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PUBLIC WORKS

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Subsoil Troubles and Remedies

Water expands about eight percent in freezing, and exerts an expansive force of approximately thirty thousand pounds per square foot. No practicable pavement or curb foundation can resist this force if water in the subsoil freezes.

No inconsiderable force is exerted in the effort of clay to expand by absorbing moisture and to contract on drying out; and such contraction in some soils causes the formation of cracks from two to (in one recorded case) six inches wide.

Some of the effects of these phenomena upon pavements are described in the following pages; also the methods employed by scores of engineers for preventing or curing the objectionable results. Prevention—forethought—is always preferable to cure.

A great many cities find that satisfactory construction and maintenance of their pavements is more or less influenced by adverse subsoil conditions, about twenty-five percent of the cities which reported in this year's paving questionnaire including themselves in this list. The trouble most commonly experienced that was due to subsoil conditions was heaving of the pavement. The next most

CRACK IN BASE CAUSED BY EARTH CRACKING, IN MACON STREET, SAN ANTONIO, TEXAS

A great deal of cracking and settling occurred in part of this street.

common was cracking of the pavement caused by contraction of the subsoil in drying out; this condition being to a large extent limited to certain localities and more or less unusual subsoil characteristics. Other cities experienced troubles due to the necessity of laying streets over swampy and wet soil, and other more or less local or peculiar conditions.

HEAVING OF PAVEMENTS.

Considering first the cities which reported heaving, we find that of the 128 so reporting, 68, or slightly more than half, reported that the pavement was laid on a subsoil of clay; and 8 reported adobe, which should probably be classed as clay. In 15

CINCINNATI AVENUE, SAN ANTONIO, BRICK PAVEMENT.

2½ inch vertical fiber brick on 1½ inch sand cushion and 4 inch cement concrete base. Black, sticky soil contracts, cracks base, and sand cushion filters through cracks, letting one end of brick down.

the soil was gumbo, in 9 loam, in 6 sand, in 6 gravel, in 4 hardpan, in 4 sandy loam or clay, in 4 wet, swampy, marshy, land, etc., and in 1 rock. Trouble with clay was reported altogether from 22 states and from Canada, these including all sections

of the country from New England to Georgia and from Oregon to Texas, with all districts in between. Gumbo was reported in 15 cases from 12 different states, between Minnesota and Montana on the north, and south to Texas and Oklahoma.

In some cases the heaving was probably caused by freezing, as in a Canadian city which reported heaving on a rocky sub-base. This explanation would hardly apply, however, to heaving in the southern states from Georgia to Texas, where swelling due to absorption of moisture was presumably the cause.

Numerous remedies applied were described by our informants, some of which were said to be quite successful, others only partly successful, and still others were more or less failures.

The most common remedy applied was drainage; and of 34 using this remedy, 22 reported it satisfactory, 9 only fairly satisfactory, and 3 unsatisfactory.

Next in popularity was the removal of several inches of the objectionable soil and replacing it with some porous material such as sand, gravel, broken stone, cinders or slag. Eight cities using broken stone all reported it as satisfactory. Of 8 using sand, 6 found it satisfactory and 2 fairly so. Of 6 using gravel, 5 found it satisfactory and 1 fairly so. Three using cinders found them satisfactory. Seven combined drainage with a porous cushion, and 6 of these found this plan satisfactory and 1 fairly so.

Seven used reinforced concrete to prevent heaving and 5 of these found it satisfactory, 1 fairly so and the other did not specify. Five employed some method of waterproofing the pavement so as to keep water from reaching the subsoil, and 3 of these reported it satisfactory and one fairly so.

A number of cities employed methods which could not be classified under any of these general heads. Glendale, California, cultivates the soil 6 to 8 inches deep, wets down thoroughly and rolls. Napa, Cal., uses a thicker base course and drainage. Pittsburgh, Cal., compacts the subgrade with as little water as possible. Dekalb, Ill., uses dowel bars at the joints, a 2-inch subbase of clay mixed with one-third sand and gravel. Granite City expects to try bars from the curb to the pavement slabs. Hopkinsville, Ky., gumbo soil, fills the road bed with big stones under the pavement. Cameron Mo., thoroughly rolls the clayey loam subgrade before paving. Henrietta, Mo., uses locked expansion joints with subdrainage in clay and gumbo soil. Fremont, Neb., scarifies the entire subgrade (sandy loam to gumbo) 2 inches deep and rolls. Rutherford, N. J. prepares the red clay subgrade with old macadam stone or with sand and gravel, and rolls with a 10-ton roller. Seaside, N. J., where the streets are founded on beach sand, places one inch of salt hay under a gravel pavement 7 inches to 9 inches thick. Solvay, N. Y., confines the laying of pavements on clay soil to dry weather and rolls well. On the other hand, Oklahoma City, Okla., where the soil is black gumbo, does not compact the subbase too much, which it finds somewhat successful. Luzerne, Pa., with clay soil, wets and rolls carefully, and finds it satisfactory. Monessen, Pa., removes 8 inches of yellow clay and replaces it with a one-to-one mixture of sand and gravel rolled in. All of the above are reported to be satisfactory except in the case of Cameron, Mo., and Oklahoma, City.

CONTRACTION OF SOIL.

The question was asked, "Do you have paving trouble due to excessive contraction of soil on drying out?" Twenty-three cities reported trouble of this kind, these being located in Arkansas, California, Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, New Jersey, Oklahoma, Pennsylvania, South Carolina, Texas and Wisconsin. Twelve of these reported trouble in connection with clay soil, 8 with gumbo soil, and the others with shale and sandy loam.

Six cities had tried reinforced concrete as a remedy, three of them reporting it successful, two fairly so and one not successful. Two California cities had used rock sub-base on adobe with success. Two cities, one in California and one in Kansas, had used gravel and sand with success and a Kansas city had used macadam base on gumbo with success. Drainage was reported by two cities, one as fairly successful and the other as not at all so. Watertown, Wisc., used contraction joints in concrete pavement on clay soil and reported this as satisfactory. Two cities were successful in keeping the subbase dry and preventing cracking by waterproofing the pavement. Kearney, Neb., uses the empty box type of armored joint in the base under asphaltic surfaces on sandy loam soil, with satisfactory results. Oklahoma City, black gumbo soil, endeavors to make an elastic base, which has proved somewhat successful. Alice, Texas, sandy loam soil, sprinkles the pavement during drying periods, believing that water is an antidote. Burlington, Wis., prepares the clay subgrade a year in advance, which appears to eliminate trouble. In Newark, N. J., trouble has been found in the Port Newark development, where ground is being made on the meadows by dreging channels therein and placing the excreted material as fill; this material cracking considerably when drying out, which drying continued after some of the roads had been constructed. They have obtained satisfactory results by placing 12 inches of cinders with underdrains and laying concrete pavement with 198 pounds of reinforcement.

Fairmont, Minnesota finds that concrete slab pavements on wet, soggy soil rise in winter but settle back in the spring; and this is the experience of Rutland, Vermont, also, with a clay soil.

Tile drains laid herringbone about 20 feet apart and backfilled with gravel have been tried in blue clay soil in Peterborough, Ontario, but not found particularly effective.

The thickness of the porous layer placed under the pavement varies considerably in different cities. Berkeley, Calif., uses a 1-inch sand cushion; Redwood City, Calif., 3 inches of rolled crushed rock; Ottowa, Kan., 6 inches of waterbound macadam; Wichita, Kan., 3 inches of sand cushion; Boyne City, Mich., 12 inches of slag; Pontiac, Mich., 4 to 6 inches of gravel; Newark, N. J., 12 inches of cinders; Corning, N. J., 8 inches of crushed stone; Gloversville, N. Y., 1½ to 2 feet of gravel; Lake-

wood, Ohio, 3 inches of rolled cinders or broken stone; Muskogee, Okla., 4 inches of top soil; Monessen, Penn., 8 inches of sand and gravel mixed; Seattle, Wash., 4 inches of pit run sand and gravel; Manitowac, Wisc., 6 inches of cinders; Oshkosh, Wisc., 1 inch of sand; St. John, New Brunswick, 6 to 12 inches of cinders; North Bay, Ontario, 12 inches of gravel.

Only a few of the cities specified the amount of reinforcement used. Morehead, Minn., uses 50 lbs. of reinforcement; Newark, N. J., 198 lbs.; Ennis, Texas, ½ inch bars on 5 foot centers.

Since the above summary was prepared, other replies have been received and will be reported next month.

In the articles below several engineers have described in some detail their own conditions and remedies.

Subsoil Experiences

Remedies for Subsoil Troubles in Wichita

Design and maintenance of pavement as affected by contraction and expansion of subsoil.

By P. L. Brockway*

The City of Wichita, Kansas, lies principally in the valley of the Arkansas river, with perhaps one-fifth of its area on an undulating ridge at one end of the valley from sixty to one hundred feet above the lowland. This higher country is covered with a very thin layer of black, tillable soil, the sub-soil consisting principally of a yellow clay shading in some neighborhoods to light red and in other locations toward white on account of an excessive percentage of gypsum. This subsoil offers a high resistance to erosion, being very tough when wet.

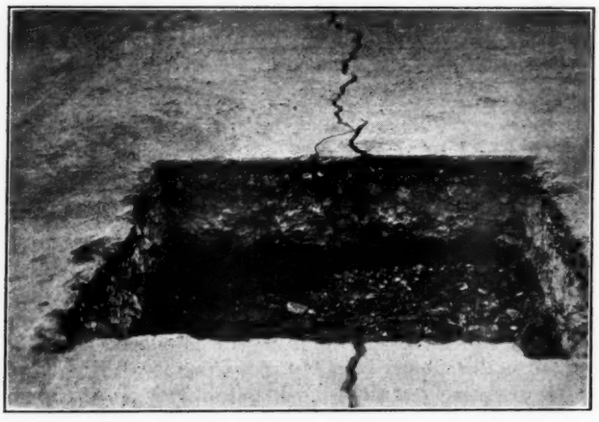
From the standpoint of improvements of all kinds, and especially the relatively thin paving slabs, its most unfortunate characteristic lies in the fact that it has an unusually high amount of expansion and contraction from wet to dry periods. By laboratory test, it contracts from a state of moisture in which it is only plastic enough to readily ball up under manipulation, to a dry condition such as is obtained in an ordinarily heated room, as much as 20% of its volume. This, of course, amounts to about 6½% linear contraction. As in this climate there is very apt to be a considerable deficiency of rainfall during the latter part of each summer,, such enormous cracks appear in the ground as to give rise to current jokes about keeping the chickens penned up in order to prevent them falling in the cracks. The soil has a fairly high capillarity so that in rainy periods moisture very readily enters into the subsoil under the pavement. The result is a constant shrinking and swelling from year to year, depending on the duration of wet or dry periods and total excess or deficiency of rainfall during them.

The first pavements were constructed on this soil about 1909. It so chanced that no abnormal weather conditions existed for a couple of years and then, following an unusually dry interval, some of the pavements were so badly shattered as to appear to be almost ruined. A square hole about three feet on each side was cut across one of the cracks to determine whether or not the cracking was actually due to subsoil shrinkage. This cut is shown in the photograph, which clearly shows the irregular crack through the sheet asphalt surface extending down through the concrete base. At the time of making the cut, there had been some rainfall so that the subsoil was again in a fairly moist condition, but it was possible to follow the lines of the original crack in the soil to a depth of three or four feet. This

TYPICAL CRACK IN CONCRETE PAVEMENT IN ITS EARLY STAGES
Edge nearest the curb is already rising above the slab in the center of the street

*City engineer of Wichita, Kans.

proved beyond any reasonable doubt that subsoil shrinkage cracked the pavement. At this time a number of samples were taken on which the average shrinkage was determined.



CRACK THROUGH BASE AND SURFACE FROM SOIL SHRINKAGE

Two remedies suggested themselves as being economically feasible. One was the use of a moderately light mesh reinforcement to make up for the deficiency in tensile strength in concrete. The other plan proposed was to excavate four inches below the bottom of the pavement and fill back with sand. This would effectively break the bond between the concrete and the subsoil and at the same time give sufficient depth to overcome any wedging action which might arise from the crown of the street. In 1912, two blocks of asphalt pavement were constructed under one contract, the only difference being that the six-inch base in one block was reinforced with 30 pounds triangular mesh reinforcement, and the other block was constructed with four-inch sand subbase. At the end of fifteen years, it can now safely be stated that both were successful. No cracking has occurred in excess of that which developed in similar pavements in almost any location. Those pavements which were laid without either precaution will occasionally continue without apparent damage for four or five years, depending on the rather irregular recurrence of excessively dry periods; while at other times, there appears to be no end to the damage because successive dry years have made a total movement in pavement slabs to such an extent that some of the cracks have opened as much as two inches and one side of the crack has subsided or the other has been elevated so that there is a maximum of two inches difference in elevation across the crack.

In more recent years we have adopted a three-inch sand cushion rather than a four, with apparently just as good results.

Neither the sand cushion nor the reinforcement which has been used in some cases entirely eliminates cracks, most of which are longitudinal with the street. It is safe to say, however, that easily 95% of them are prevented and that the remainder do not open so wide nor do they have so severe a vertical movement.

We have standardized on the three-inch sand sub-base because local sand is available at such prices that it is cheaper to take out the soil and fill back with sand than it is to use the mesh reinforcement. Concrete pavement in all cases is constructed with a transverse joint at thirty-foot intervals and has also been constructed with a longitudinal center construction joint for fifteen years. In those streets which were constructed without sand sub-base, longitudinal cracks developed in slabs that were thirteen feet wide, and the center crack widened and settled quite similar to cracks which formed after the pavement was completed. A highway pavement eighteen feet wide built without expansion joints was badly shattered the second season after its completion by soil shrinkage. This pavement was of the type in common use at that time, the slab having a flat bottom, with a two-inch crown, seven inches thick on each edge and nine inches in the center. It was made of concrete of unquestionable quality.

Poured concrete foundations for expensive homes are cracked in the same way. One master builder reports that he prevented it by placing sand under the footings and a light reinforcement in foundations and basement walls.

As to maintenance of those pavements which are cracked, soft-top pavements are repaired by cleaning out the cracks in hot weather with scrapers, brushing them out with home-made brooms made with worn wire stands from the brooms on pick-up street sweepers, pouring the cracks full of hot asphalt of about thirty-two penetration, sealing the crack with hot smoothing irons and dusting it over with stone dust or cement. In those streets having moderately heavy traffic, many of these cracks are so well annealed as to be difficult to detect within a few years.

In brick pavements having an asphalt filler and a sand cushion, the effect of the cracks is to let the sand cushion run out and the bricks gradually settle down over them. These are repaired by removing the brick and cleaning them for relaying, cleaning out the crack and pouring it full of hot asphalt, followed immediately by a hot dry sand, which settles in the asphalt, tending to form a mastic which will not flow out, then bringing the sand cushion up to its original contour, relaying and refilling the brick surface.

Cracks in concrete pavement were repaired at first by pouring them full of asphalt of fairly low penetration. At the end of two years it was rather difficult to determine that any asphalt had ever been poured in the crack because it simply ran on down into the crack in the ground during the next dry, hot period. For this reason, during the last ten years, an asphalt mastic has been made by mixing hot sand with about twenty per cent, by weight, of hot asphalt in an ordinary asphalt mixer. This makes a product which runs rather easily while it is hot and yet flows very, very slowly at the maximum street temperatures. It has been found that such repairs will last from five to ten years, depending on further shifting of the slab by subsoil movement.

Heaving of Yellow Clay Subsoil

By Thomas Finnie*

Many cities in this vicinity have found that under the tremendous loads which modern traffic has imposed, the old type of brick pavement does not stand up and in some cases even becomes almost impassible in a short time. One significant fact should be noted, namely, the brick on these streets were equal in many respects to the brick used in the construction of many of our modern streets and highways which are successfully withstanding the heaviest of traffic. Consequently the brick is not the cause of the uneven contour of the surface but this must be sought for elsewhere.

In repaving the main street of the city of Monessen, Pa., the conditions encountered verified the conclusion previously reached, that almost without exception all cases of uneven surface are due entirely to sub-soil conditions, with the type of base as a secondary contributing cause.

The soil in this vicinity is a yellow clay deposit approximately 8 feet thick. In the repaving work referred to, after removal of the old brick surface and the original slag and gravel base, the contractor used a 10-ton roller as required by the specifications. These specifications further required that "any part of the sub-soil which indicates weakness or sponginess shall be immediately removed to a depth of 8 to 10 inches, and crushed stone mixed with sand and gravel in equal proportion shall be replaced. This shall be rolled to conform with the grade." It was found that as soon as the roller had passed over the clay, it would rise above the former position at least three inches. This sponginess was peculiar in that it would yield under foot pressure at least two inches, resembling soft rubber. We found that the only remedy for this condition is to remove absolutely all clay of this nature. Rolling only makes conditions worse. The clay is of such nature that it will absorb a certain amount of moisture up to its saturation limit, and upon reaching that limit becomes almost impervious to additional water; and unless the surface has been disturbed by trucks or wheels, this spongy condition does not penetrate to a greater depth than 6 inches.

A trench should never be backfilled with this type of clay during the grading of the street, for almost invariably it will be necessary to remove all of the material a second time and replace it with other material. This clay has been known to remain spongy in a trench, even during dry weather, for three weeks, and seems never to dry out thoroughly.

The rigid type of concrete pavement, whether the surface is brick or asphalt, is best suited for conditions of this kind.

The following is our specification: 6-inch concrete base, reinforced with National Fabric Company wire mesh. Concrete mix 1-2-4. One-inch reinforced steel bars parallel to the street railway track and 18 inches from the rail. A one-inch sand cushion and 4 inches of brick. Asphalt filler was used. This street, after four years' of heavy traffic, shows no sign of heaving but retains its smoothness.

Based on his experience with this material, the writer would make the following recommendations. Do not excavate the low points on the grade unless assured that the concrete mixer is following closely; otherwise a quag-mire may result. Close attention to grading and sub-soil conditions with this yellow clay will eliminate most of your troubles. By all means use either asphalt filler or grout filler, preferably the former, remembering that water is the real trouble-maker where yellow clay exists.

*City Engineer of Monessen, Pa.

Subsoil Trouble in Boyne City, Mich.

Editor, PUBLIC WORKS:

In answer to your request I briefly describe our experience with subsoil trouble under concrete sidewalks, curbs and gutters, and pavement.

Our troubles have occurred on water-bearing or clay subsoils on hills where water comes to the surface between the top and the middle of the hillside. The typical soil strata are: 1 sand, 2 a red sandy hardpan, 3 a stratum of waterbearing sandy soil mixed with marl and clay, 4 a stratum of blue clay soft at the top but becoming more compact at greater depths. (See Fig. 1.)

In each case we cut across all these strata, grading for walks, curbs, and pavements. We built walks on two hills and curbs on one, to replace former broken curbs and walks, placing 18 inches of slag—coarse from the furnace—hammering it down with sledges for subgrade; previously laying a 4-inch bell tile in the bottom of the trench, using oakum loosely packed in the bells to stop coarse sand. This subdrain was connected into the storm drain. (See Figs. 2 and 3.)

These walks and curbs have not cracked, heaved, or settled during the six years for curbs, or 15 years for walks, that they have been down.

We placed the concrete directly on the coarse slag; no fine aggregate used to level-up the subgrade. This method insures drainage and *provides air spaces* above the water filled soil.

Our pavement on the same hills was laid under direction of the State Highway Department. Their engineers did not favor slag on account of the initial expense, but chose to lay a system of drain tile about 18 inches below the subgrade at close inter-

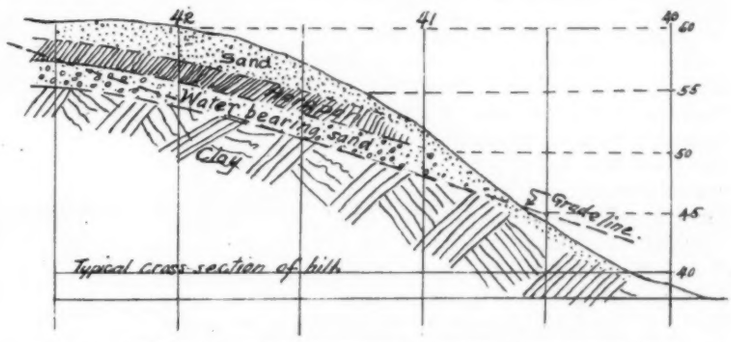


FIG. 1—TYPICAL CROSS-SECTION OF HILL, SHOWING SOIL STRATA.

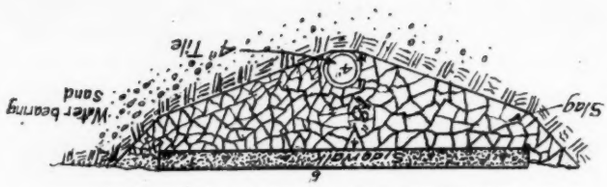


FIG. 2—DRAINAGE UNDER SIDEWALK

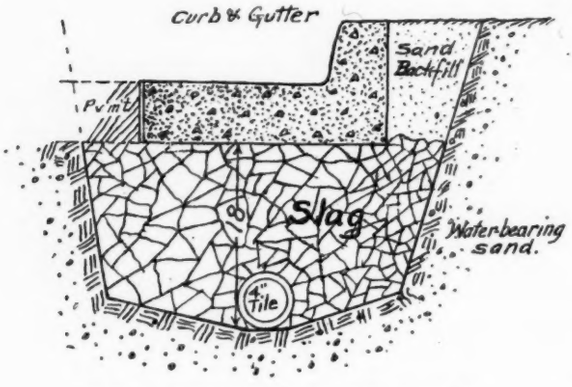


FIG. 3—DRAINAGE UNDER GUTTER

vals. These drains have proved to be inadequate. They only remove the excess of water, leaving the soil saturated at all times. They do not provide air spaces next to the pavement. Frost has caused these pavements to heave and break-up, some fragments faulting as much as four inches.

Had there been 18 inches of coarse slag laid for the subgrade with a line of 4-inch tile parallel with the center line each six, or even ten foot interval, I am of the opinion the airspaces would have prevented even cracking, not to mention heaving.

Air spaces underneath concrete pavement is the surest cure for cracking if suitable contraction joints are provided.

Yours truly,
E. A. ROBINSON.

Boyne City, Mich., Jan. 29, 1927.

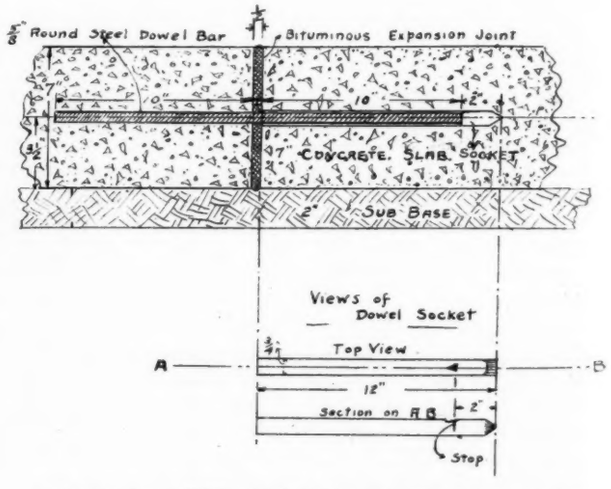
Sub-base at De Kalb, Ill.

By W. M. Hay*

In concrete pavement construction, where a rigid, steel-reinforced concrete pavement rests directly upon a base of compacted earth, there is a marked tendency for the surface to become uneven, and at expansion joints for one slab to become elevated or depressed from the adjoining slab, due to the continuing results of temperature and moisture changes in the base. Freezing, thawing, heaving, swelling and shrinking of the sub-soil due to the moisture therein, especially if the soil is heavy clay, cause vertical movements in the slab which can be materially reduced by the use of a sub-base and by the use of dowel bars to hold the concrete slabs together at expansion joints.

For the sub-base I specify that the grading shall be done roughly to a grade one-half to one inch below the required sub-grade, making due allowance for the nature of the soil in rolling and compacting. The surface is then disked for a depth of approximately two inches and enough sand, gravel, boiler cinders or satisfactory road metal added to produce about a one-third mixture of such material with the upper two inches of the surface. After uniformly spreading and harrowing this material into the disked sub-base, it is rolled and compacted to present a firm, even, solid, granular surface at the required sub-grade. The construction of a sub-base may be unnecessary at certain points, where the required granular condition already exists, but the disking should be continued through these places to expose the existing condition and to secure uniform compaction when rolled.

To keep the pavement slabs together as a unit so far as variations of surface are concerned and to retain them together on the sub-base at the same elevation, I provide for the use of 5/8-inch round steel dowel bars 20 inches long, to be installed four feet apart horizontally through, and extending equally on each side of, the bituminous expansion joint into the concrete and midway in the slab. To provide for slippage for expansion and construction, a steel tubular dowel socket of 3/4-inch inside diameter is installed over the dowel bar on one side of the joint. This socket is 12 inches long and one end of the tube is closed by pinching the tube shell together at the factory where manufactured. Two inches from this end a V-shaped slit is made in the wall of the tube and the metal pressed inward at a right angle to the tube wall forming a "stop" for the dowel bar. In construction work, this stop protects the same from a rigid installation which would result in the breaking of the concrete at the joint. The slippage space allowed for is one inch or more in length. If any apprehension may exist that the cement mortar may creep in between the dowel bar and the socket, the installation may be dipped in waste oil before the concrete is placed around it. The accompanying drawing illustrates the plan of installation and the sub-base below. In construction work so far done, very little extra work and no delays have been caused by the installation of the dowel bars and sockets. The cost of the sockets per 1,000 range from $25 to $30, depending on the number ordered.



EXPANSION JOINT, SHOWING DOWEL BAR AND SOCKET.

*Consulting Municipal Engineer, De Kalb, Ill.

Subsoil Troubles in Rutherford

By Robert M. Watson*

In the several small municipalities located on the ridge between the Passaic and Hackensack valleys, New Jersey, the soil is generally gravelly and sandy with some clay admixture and pockets of disintegrated shale, on top of "new red sand stone." These pockets generally contain water, or at least moisture, and wherever this shaley material is confined so that no flowing can occur, we have excavated two or three inches below the surface of the subgrade and stiffened the surface of the subgrade by depositing two or three inches of old macadam stone or gravel, rolling this and driving it into the soil with a 10-ton roller. On this the pavement is laid as usual. Wherever there is an excessive amount of moisture or water a system of underdrains is laid. We have had very few failures of any of our pavement work.

The most extreme instance of soft subgrade which we have experienced was in a cut 800 or 900 feet long and about 12 to 15 feet deep at the summit tapering to nothing at the ends of the cut. This was paved with Amiesite 36 feet wide in 1908 under State Aid. Considerable moist and shaley material was encountered in the subgrade here and was quite spongy in spots during the rolling. Six-inch vitrified pipes were laid along the gutter lines on each side of the roadway 2½ or 3 feet below grade in a trench 18-inches wide. This pipe was surrounded with broken stone two or three inches under the pipe as well as around it and over it and was topped with coarse sand and gravel. About four months after these drains had been laid, during freezing weather, a blow-up occurred in the center of the pavement at the summit, the pavement being raised about 12 inches above grade. An area of about 30 feet by 10 feet of pavement in the center of the roadway was removed and underneath the blowup we found a large pocket containing clean, coarse sand and gravel. This was excavated for a depth of about three feet, or below the frost line, and 6-inch vitrified drain pipe surrounded with broken stone were laid leading from the hole to each side and connected with the gutter drains. The large hole was then filled with cobble stones and other large stones laid by hand in layers and the interstices filled with old macadam stone, gravel and sand, and the whole rolled with a 10-ton roller. The pavement was then relaid and no trouble has since occurred at this point; in fact, it would be difficult to find the location of this repaired pavement, which sustains heavy truck travel and apparently will serve this traffic for a long time to come.

Our latest practice for trap-rock macadam pavements is to use a black base 6 inches thick, making two applications of the densest grade of asphalt, 350 degrees Fahrenheit, about 1½ gallons per square yard for each application for each layer of broken stone and ¾ of a gallon per square yard for the top seal coat. This type of pavement has proven to be the best and most economical for our ordinary heavy trucks and other vehicular suburban traffic. We have laid over five miles of this type in Rutherford and it has been in use for the past five or six years, with no ravelling, no replacements, no blow-ups, and the pavements are still in service and apparently will be for many years to come.

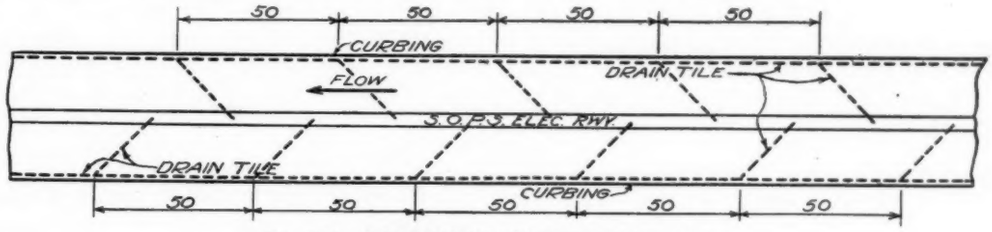
*Wise & Watson, Consulting Engrs., Passaic and Rutherford, N. J.

Subsoil Drainage at Zanesville

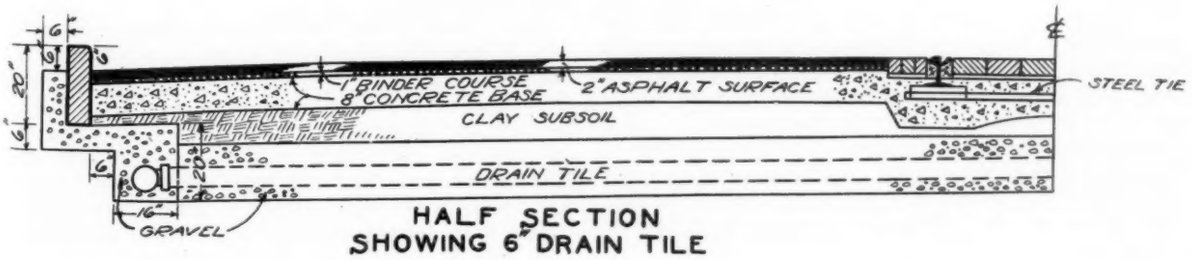
By C. R. Spencer*

Greenwood avenue, Zanesville, O., which is a part of the National Highway, was paved some 25 years ago with brick, sand-filled, upon a gravel foundation, with 4-inch drain tile placed back of the curb. The sub-soil is a yellow clay underlaid with shale. Each spring, in later years, there were upheavals of the brick in many places which, after the frost had disappeared, the Street Repair Department would remove, together with about a foot of clay, fill with gravel and relay the bricks. This continued until 1925 when a contract was let for repaving the street. In removing the old curb we found that at every place where service companies had erected poles, and in many places where gas or water lines had

*City engineer, Zanesville, O.



PLAN SHOWING METHOD OF PLACING 6" DRAIN TILE



HALF SECTION SHOWING 6" DRAIN TILE

been put in, the drains had been broken out and no effort made to replace them. To avoid this in the future, the longitudinal drains were placed in the roadway as shown.

The six-inch drain tie was placed immediately after the rough grading was completed; the washed gravel, which was screened through one-inch openings, being thoroughly tamped, after which the trenches were topped with a layer of earth, and the entire surface then was fine-graded and rolled.

Each diagonal drain was started from a 6"x6" vitrified "Y" branch placed in the main portion of the drain and a two-foot length of six-inch vitrified sewer pipe used for connecting portions of the main drain with convenient catchbasins.

Fairmont avenue, a residential street, was paved about fifteen years ago by a real estate dealer when laying out a new addition which was then outside the corporate limits. This pavement was laid on the sandy clay sub-soil with only enough sand cushion to bed the brick, which were of an inferior quality, and a cement grout filler used with no provisions made for expansion. After several "blow-ups" and the regular annual repairs, the Council decided, and insisted, upon resurfacing the street instead of putting in an entire new pavement, as advised. We used the same method of placing drain tile as was used on Greenwood avenue, making special effort to have diagonal drains leading from the wettest portions of the street. Six inches of concrete was then placed over each drain trench and the whole surfaced with sheet asphalt. This was two years ago, and to date the street has remained in good shape.

Portions of each of these streets have grades of six and seven percent with fairly high ground on at least one side, and the most of the trouble developed near the foot of these grades and, while the idea is not new, we thought it the best method to use and subsequent inspections of the several outlets of the drains into catchbasins have shown enough water to lead us to believe it will be entirely satisfactory.

I don't think there is any question about the permanency of the Greenwood avenue improvement, with the eight inches of concrete base, but on Fairmont avenue there is a possibility of future trouble.

Heaving Concrete in Altoona

By H. J. Baum*

The city of Altoona, Pa., has paved some alleys with reinforced concrete slabs 12 feet wide through the center of the alley with an 18-inch slab on each side, giving a total width of 15 feet. In doing this we found that on certain soils, particularly clay, the outside slabs would be displaced vertically up to a maximum of 2 or 2½ inches during the late winter and early spring, and later on in the summer would go back to about the original elevation. In some places the movement appeared to be at one edge of the central slab, the outside slab remaining at about its original elevation. As the ordinary traffic through the alleys of the residential section is light, we changed the design to a one-piece reinforced concrete slab 6 inches thick at the center and 7 inches at the outside edges, and have not experienced any excessive cracking in these pavements, although laid on the same kind of soil.

Most of our streets are paved 30 feet wide in one continuous slab, expansion joints being placed along the curb, at street intersections, at severe breaks in grade, and at the end of each day's run. In three different places, all on clay subsoil, I have noticed a vertical displacement approximating two inches as evidenced by the lifting of the manhole rings from their foundations. In all these locations there was found to be an excessive amount of water saturating the subgrade. As a remedy at one point, we constructed a storm sewer to take off the saturating drainage; and at another place the condition will be greatly relieved when we complete the excavation of the approach to the street intersection, where at the present time the surface drainage is imperfect.

In order to prevent the heaving of our pavements, we investigate the moisture content of the clay subgrade, and wherever surface indications show a percolation of water in the embankment, we construct a 4-inch terra cotta pipe drain along the outside of the curb, 6 inches deeper than the base of the curb, and place a stone fill directly back of the curb carried to the surface 8 inches wide. We have found this method very effective in drying up the subgrade. To cite one instance, last year, at a point where it was found impossible to use a three-ton hand roller immediately after excavation, two days after drainage the subgrade was rolled with a 10-ton steam roller. In this instance as well as in other places where the contractor experienced trouble in rolling the subgrade, the necessary fills are made with cinder and stone, the thickness depending entirely upon the amount which the steam shovel took out below the subgrade and varying from little or nothing up to a maximum of four or five inches, depending upon the accuracy of the steam shovel cut. The cinders or stone are supplied voluntarily by the contractor, no such provision being made in the specifications for the improvement of the subgrade, dependence being placed entirely on the drainage back of the curb. In any event, we consider drainage to be a fundamental procedure for minimizing or eliminating the heaving of pavements under such conditions, although the application of either stone or cinder fill proves beneficial after the saturating water has been removed.

* City Engineer of Altoona, Pa.

Frost Boils in Wisconsin Roads

Treatment of "frost boils," or local heaving, due to freezing of the sub-grade, in Wisconsin highways, is briefly described as follows by N. M. Isabella, maintenance engineer, Wisconsin State Highway Commission:

On quite a number of roads in Wisconsin it has been found that break-ups occur in practically the same location every spring. Some of the commissioners have facilitated break-ups or "frost boils," as they are often called, with the use of dynamite. In this way, they open up the section of the road that is bad and allow the moisture to drain out as the frost comes out. In quite a number of cases it has been necessary to plank the road and permit only one-way traffic on short sections.

Another method that has proved quite satisfactory in the treatment of "frost boils" is as follows:—Take the section of road where the break-up is apt to occur, close half of the roadway, and dig a trench across the road down to at least the depth of the side ditches. This will permit the frost to drain out to the side, and will not disturb the surface. After this has drained for a few days, the trench may be filled in with stones and gravel and then covered with the regular surfacing material.

Underdrainage of Pavements in Gloversville, New York

By H. J. Hanmer*

For the past three or four years the city of Gloversville has taken more than ordinary pains with the substructure and underdrainage of its pavements. Very few cracks have developed in the pavements that have been constructed during this time and I believe most of those cracks are due to the contraction and expansion of the concrete, rather than to the lifting of the pavement due to frost.

During the past three or four years all heavy or clay soil has been excavated to the depth of from 1½ to 2 feet below subgrade, and the same has been refilled with a fair grade of gravelly or porous soil, free from clay, muck or vegetable matter.

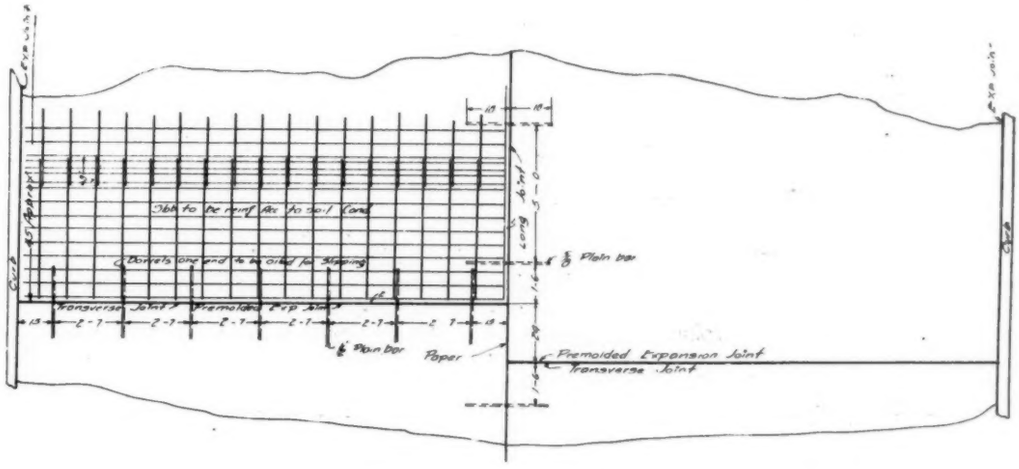
*City Engineer, Gloversville, N. Y.

In addition to this, underdrains of vitrified pipe or pipe of the agriculture type have been placed to the depth of 18 inches below the bottom of the curb, which is 12 inches below the surface of the pavement, making the invert of the underdrains 30 inches below the surface of the pavement at the curb line. These drains are covered with broken stone to the depth of 8 inches above the top of the drain and have a width of 10 inches. The bottom of the excavation is then graded from the center of the roadway towards each underdrain, having the same fall that the pavement has from its center to the curb.

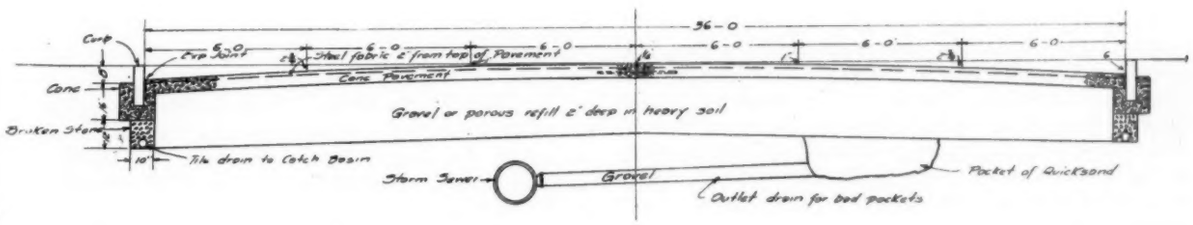
Surface water sewers are constructed on all streets previous to the construction of the pavements, and catch basins are constructed at the curb line about 250 or 300 feet apart and are connected into the surface water sewers. The underdrains in turn are connected into the catch basins, thereby furnishing ample underdrainage for the soil under the pavement.

During 1925 one contract of 6,435 square yards of reinforced concrete pavement was completed at a cost of $3.25 a square yard. This price covered the excavation and grading to the bottom of the pavement, the six-inch concrete pavement including reinforcement of 65 pounds per hundred square feet, and the carpet wearing surface of two-thirds gallon of Tarvia "A" to the square yard with the stone chips.

Of the above area 2,540 square yards was laid on clay soil which was excavated and refilled to the



PLAN SHOWING JOINTS & STEEL



SECTION SHOWING METHOD OF DRAINING SUBBASE

depth of 2 feet with porous soil and 1,377 feet of underdrains were laid under the curb on both sides of the street within this area. The cost was made up as follows:

Excavation	$2,106.00
Refill	3,268.00
Underdrains	283.00
Broken stone	198.00
	$5,855.00

This amount, spread over the 2,540 square yards, made a cost of $2.30 per square yard for that area of additional excavation and refill.

As this extra cost was spread over the entire contract of 6,435 square yards the extra cost for the pavement was 90 cents per square yard or about 22 cents per square yard to the city and about 68 cents per square yard to the abutting property owner, as the property owners pay 75 per cent and the city 25 per cent of the cost of all original pavements that are laid on the streets for the first time. The entire cost of repaving is borne by the city.

Heaving in Nutley

In Nutley, N. J., where the soil is reported by town engineer, O. A. Luck, to be a medium to poor clay, a concrete road over a year old and containing several thousand yards, showed very pronounced heaving which varied between ½ inch to 2 inches. Another road of 2,500 square yards of 7-inch Vibrolithic concrete, reinforced with 36 pounds of steel mesh per 100 square feet, showed heaving amounting to ¾ of an inch at one manhole. Here the clayey soil was removed to a depth varying from 2 to 6 inches and 55 tons of 2½-inch stone and 65 tons of sand mixed were spread over the subgrade.

This work has been completed only two or three months and it will not be possible to be certain until after next spring's thaw whether it will be effective or not.

Irrigation With Denver Sewage *

Now taken from river, into which it is discharged, through an irrigation ditch to irrigate about twenty thousand acres. No nuisance created. Farmers have presumably acquired right to this use. Advantages and disadvantages of this use.

By Chas E. Burdick†

The sewage of Denver, Colorado, is essentially disposed of by application to land in the process of irrigation. This has been accomplished by the agriculturists below the city, unconsciously so to speak, and without expense to the city. In a method of disposal that has grown up rather than been planned there are some imperfections which will become emphasized as the city grows. The time is not far distant when some corrective measures must be taken through artificial purification. The situation as it exists, however, has so many natural advantages that engineers will probably be interested in a description of it.

Denver is drained by the South Platte river, which bisects the city flowing north. The city is naturally well drained, the ground rapidly rising 200 to 300 feet above the banks of the river. The present population of the city is approximately 275,000. The city is sewered on the separate system. All sewage is discharged immediately at the north city limits, nearly all of it into the Platte river.

About one mile north of the city limits are the intake works of the "Burlington Ditch," with a low diverting dam and gate. During the irrigation season, from April to October, this canal may take surplus river flows only. During the remainder of the year it usually takes practically all of the flow of the river, including all of the city sewage, which is carried through the canal a distance of about twelve miles to Barr Lake, and when desired it may flow to several other reservoirs serving to irrigate about 98,000 acres of land lying northeast of Denver. During the irrigation season, irrigation rights prior to those of the Burlington Ditch system require that water, when needed, must pass northward down the Platte, from which it is diverted at various places and discharged upon land; returning to the river, to a greater or less extent, as seepage, and is rediverted probably several times in passing through the semi-arid plane country of eastern Colorado.

The water consumption of Denver is relatively high. The average sewage flow at present is about 75 second feet or about 175 gallons per capita. This is equivalent to about 55,000 acre-feet per year. The total capacity of Barr Lake is 32,000 acre-feet, and additional reservoirs more or less interconnected serving the 98,000 acres of land bring the total reservoir capacity to about 78,000 acre-feet, which is 50 percent more than the total annual flow of the Denver sewers.

During the warmer months of the year from May to September the dilution water available in the Platte river is sufficient to produce a minimum dilution of 3 second-feet per 1,000 population only 60 percent of the time. During the late summer and early fall the available diluting water is much less than that ordinarily considered sufficient to prevent nuisance, often falling to one-half second-foot per 1,000 people.

Outside of the irrigation season, namely from October to April, during which time the Burlington Ditch usually takes all the river flow and sewage

*Extracts from paper before the Illinois Society of Engineers.
†Of Alvord, Burdick & Howson, engineers, Chicago.

the available dilution water is usually less than one-half second-foot per 1,000 people. Upon the average, three second-feet per 1,000 people is available only 4 percent of the time.

The conditions along the river below Denver and in the ditches and reservoirs receiving sewage are not as objectionable as would be expected. The health conditions of the locality are good. Odors and unsightly conditions are often present. The country, however, is entirely rural and quite thinly inhabited closely adjoining the rivers and ditches. No formal complaints have been presented to the Board of Health. No suits are on file against the city.

The situation is unusual in another respect. The sewage of Denver contains enough water to irrigate 20,000 acres of land. It constitutes nearly one-fifth of the water needed by the Burlington Ditch lands. The moisture in the sewage is estimated to confer a gross benefit approximating four millions of dollars. In addition to its moisture, the sewage has a fertilizing value when applied to land in reasonable amounts. A few analyses indicate about 1,600 pounds of suspended solids per million gallons. The larger part of the fertilizing value, possibly as much as 60%, is covered by free ammonia, all of which could not be made available under any practicable means of distributing sewage on the land. At Denver there is no doubt, however, that the sewage adds materially to the fertility of the land receiving irrigation from it.

Under the irrigation laws it is probable that the present users have acquired the right to Denver sewage. There is no prospect that they could be deprived of it without serious protest, and the payment of heavy damages. The topographical situation is such that when it becomes necessary, the sewage may be purified and returned to the present users entirely by gravity, at the loss only of a major part of its fertilizing value.

Sewage disposal by broad irrigation has been applied in the United States in several instances, and it generally has been abandoned for various reasons, particularly the unsuitability of the soil, and the abundant rainfall in the eastern part of the United States. In the more arid parts of the country, sewage farms, where built, have generally suffered the fate of most works for sewage purification, namely, lack of intelligent operation, and in the more thickly settled parts of California, the desirability of the disposing of the sewage upon smaller areas.

The present situation in the disposal of the Denver sewage has a number of advantages not found at other places where broad irrigation has been used. These advantages are as follows:

(a) The total sewage is only 6 inches per year upon the lands subject to irrigation.
(b) Storage facilities are available to apply the sewage when needed.
(c) The fertilizing matters contained in the sewage are not in excess of the reasonable requirements of the land.
(d) The rainfall in the locality is such as not to interfere with the proper utilization of sewage on the land.

The disadvantages of this method of disposal at Denver are as follows:

(a) The possibility of nuisance to inhabitants in proximity to the main canal and reservoir.
(b) The danger that might occur through irrigating certain garden crops which are consumed raw, and might transmit disease.

The irrigated lands below Denver are most largely used for such crops as sugar beets, corn, grain, potatoes and hay. Truck gardening is produced to a considerable extent close to Denver.

The use of sewage on raw vegetables is dangerous. It would still be dangerous even with purified sewage. A small part of the cost of purification applied to inspection would probably relieve serious harm from the use of sewage in agriculture of a proper kind.

The present situation is relieved from nuisance principally by the relatively uninhabited character of the country below Denver. As the city grows, the nuisance in certain localities will probably become intolerable. When this time comes, the city will necessarily resort to sewage purification works. Nothing short of filtration will entirely relieve objectionable conditions at all places below Denver. Complete works would cost about $4,000,000 at this time and the operating costs would be about $75,000 per year. The annual saving by the postponement of these expenditures will go far in minimizing local nuisances as they become intolerable, at least for some years. Artificial purification is indicated as the probable ultimate solution.

Jamaica Sewage Treatment Plant

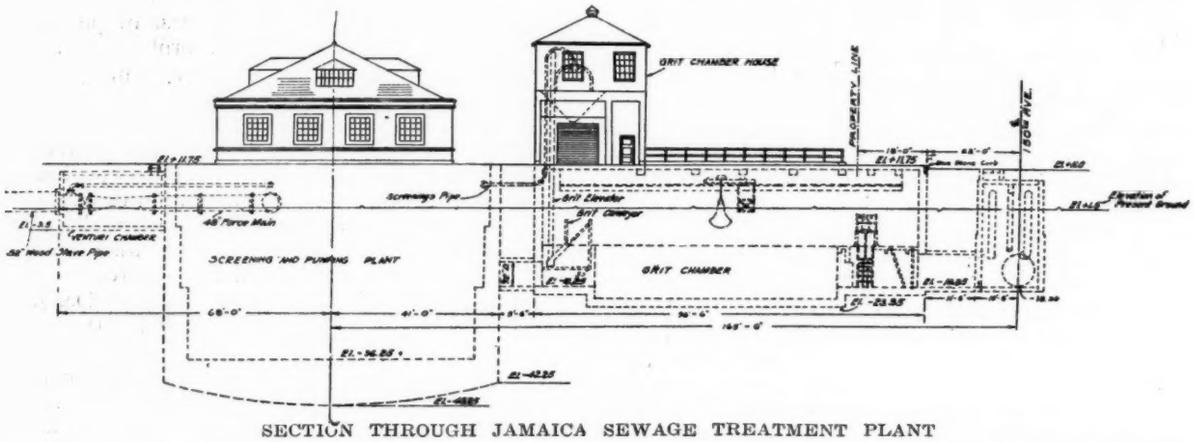
Recently completed for screening and chlorinating eighty million gallons per day. Set in pit fifty-four feet deep.

The first of three 80 m.g.d. units of the Jamaica sewage treatment plant for the Borough of Queens, New York City, has recently been completed. It consists of grit chambers, screens and pumps. The effluent is chlorinated and discharged through a wood-stave pipe into Bergen Creek and thence into Jamaica Bay. This plant handles sewage from both separate and combined sewers. Ultimately additional treatment may be given, if needed, but for the present, only screening and chlorination are contemplated.

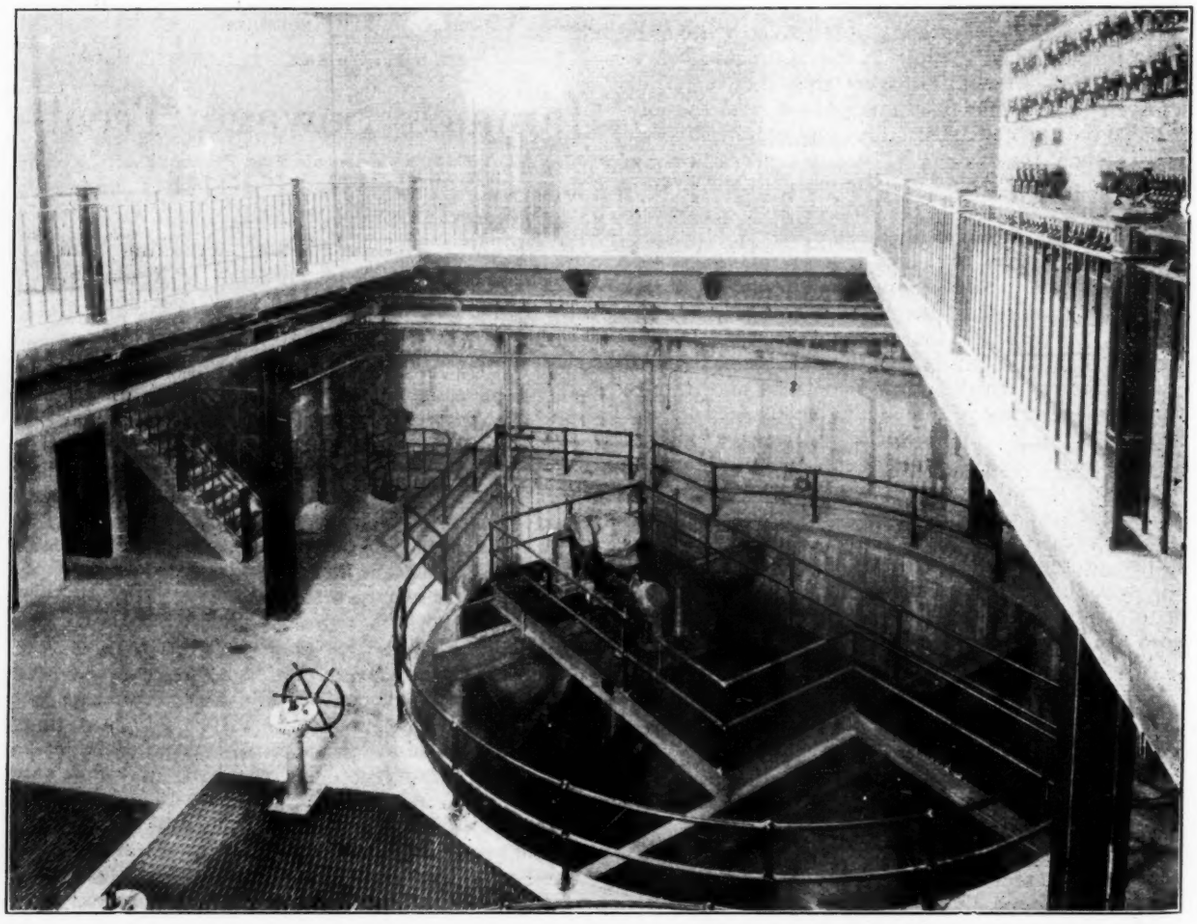
Sewage reaches the plant through one 96-inch and two 18-inch sewers. It first passes through an 8-foot gate, which controls the flow of sewage into the plant, and a bar screen, after which it flows into a four-channel grit chamber, about 40 feet by 60 feet by 12½ feet deep below the flow line (but 33 feet below the ground surface). Entrance of the sewage into each of the grit channels is controlled by manually operated gates, 4 feet by 6 feet, of the Sanitation-Geiger type; and at the outlet end are electrically operated gates of the same size, so that any one or more of the grit channels may be taken out of service.

A main influent gate of the Sanitation-Geiger type, 6 feet square, controls the flow of sewage into the pumping and screening station. This gate, like those at the grit chamber, is of cast iron, with bronze seating rings, bronze roller guides, and adjustable roller wedges. From the main influent chamber are two outlets leading to two Sanitation disc screens, each outlet being equipped with an individual gate, so that either unit may be taken out of service if desired.

The two screens are each 26 feet in diameter, of the Sanitation curved-slot type, made up of monel metal strips set on edge 1/32 inch thick and 3/16 inch wide, spaced 3/32 inch apart, giving an open area of about 69 percent of the screen surface. The screens are equipped with a water and oil spraying system for cleaning the surfaces and slots of the screen. The cleaning brushes have a special device for removing grease and scum. A guage is provided showing directly the loss of head through the screen. In addition to switchboard control, the screens may be controlled by individual pushbuttons, and are further automatically controlled by float switches operating in the influent channel and so



SECTION THROUGH JAMAICA SEWAGE TREATMENT PLANT



INTERIOR OF JAMAICA PLANT, SHOWING ONE OF THE SCREENS. SWITCH-BOARD ON THE RIGHT

arranged as to start at a high water mark and stop at a low stage. These float switches may be cut in or cut out of service as desired.

There are four main pumps consisting of three 30-inch units direct connected to 300 h.p. motors, each unit having a capacity of 31 m.g.d.; and one 24-inch, direct connected to a 250 h.p. motor, with a capacity of 22 m.g.d. All pumps are horizontal, single suction, mixed flow type. The pump cases, valves and impellers are of cast iron; the shafts are protected with bronze sleeves, and the cases, impellers and valves provided with bronze wearing and seal rings. All pumps are normally controlled by automatic float switches, but may be controlled manually.

For removing drainage and leakage, there are two sump pumps which discharge into the 48-inch force main leading from the plant. These pumps are 4-inch, single suction volute, each driven by a 7½ h.p. motor through a vertical shaft and centrifugal friction coupling.

The effluent from the pumping station is dosed with liquid chlorine by five Wallace & Tiernan automatic solution feed type chlorinators, with a range of capacity of 10 to 80 m.g.d. Automatic control of chlorine dosage is accomplished by the use of pump solenoid operating valves, the chlorinators functioning whenever the pump starts.

The sewage pumped is measured by means of a venturi tube equipped with an electrically operated indicating, recording, and integrating flow meter and with a capacity up to 80 m.g.d.

Settlings from the grit chambers are removed by a traveling crane and clam-shell bucket, and deposited in a grit hopper, whence they are removed by a screw conveyor to a bucket elevator which raises them to a grit storage tank. Sludge or screenings are deposited in a pneumatic hopper of 24 cubic feet capacity, which, when filled, is sealed and the contents discharged into sludge storage tanks by compressed air. A truck passageway under the grit and sludge storage tanks allows direct loading. Grit and sludge, for the present, will be used for fill, but later the sludge will probably be incinerated.

The screening plant and pumping equipment are located within a concrete caisson 82 feet in diameter, sunk to a depth of 54 feet. As the soil is waterbearing sand, the surface elevation of which is slightly below mean high water in the bay, sinking the caisson presented some difficulties. It was built as an open end cylinder, with 6-foot walls heavily reinforced, but without a metal shoe, and sunk by excavation inside the walls. There was some trouble from sand boiling up under the foot of the caisson, but no major difficulties were encountered. After the caisson had been sunk, the bottom, which is 16 feet thick in the center and 7 feet at the edges, was poured, the concrete being placed under water.

The contract price for the plant, including sewer connections, grit chamber, buildings, sewage treatment and pumping plant, outfall, and all equipment, was $1,656,949. Plans and specifications were prepared by the Bureau of Sewers of the Borough of Queens, under the supervision of Frederick Seely, engineer of design, and Arthur S. Tuttle, chief engineer of the Board of Estimate and Apportionment of New York City, and under the jurisdiction of M. E. Connolly, borough president.

New Water Supply of Kinston, N. C.

Well supply of nearly nine hundred gallons per minute obtained from one well about three hundred feet deep, through an eighteen-inch screen and casing.

By John E. Weyher*

Kinston, N. C., is a thriving city of twelve thousand population, located in the central eastern portion of the state near the western edge of the coastal plain, in the valley of the navigable river Neuse. The city's experience with water supplies is about the same as that of most growing cities and towns.

The original supply was from wells drilled in the bottom along the Neuse river, as the wells here were flowing or artesian; and, as is usual, it was thought that this was the most prolific source of supply. Seven 4-inch wells 290 feet deep, and three 10-inch wells 510 feet deep, were drilled. The total measured capacity of these ten wells was 230 gallons per minute.

This supply, while never more than sufficient, filled the needs of the city until 1922, when it was decided to go about three miles west of the city, where some small farm wells were flowing. Here two 8-inch wells were drilled to a depth of 350 feet. These wells were of the standard type, in use for the past fifty years in all parts of the world. That is, a churn drill rig put down an eight-inch casing into the sands and split and screened the casing.

These wells produced about 150 gallons per minute, and it was contended that when pumped they practically stopped the flow of some of the farm wells, which ended in a law suit and a judgment of $10,000 rendered against the city.

The total cost of pipe lines, pumps, buildings, wells, etc., was $65,000. The cost per gallon per minute for this development was approximately $433.

In 1925, on account of the rapid growth of the city, it became necessary to develop additional water. The Neuse river was available, very near the pumping station, and filtration was suggested and carefully considered. The water from the wells is of

* Superintendent Electric Light and Water Dept., Kinston, N. C.

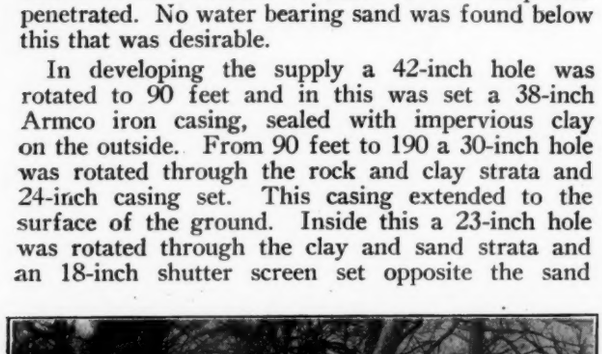
most excellent quality, and it is doubtful whether water from the river can be filtered and treated in such manner that it will remove the organic and swampy taste prevalent in nearly all surface water on the coastal plain even after treatment.

It looked, however, as though a filter plant and river water at a cost of more than a hundred thousand dollars was the only solution left, when an advertisement of the Layne & Bowler system was seen, and on writing them, an engineer from their eastern subsidiary made a thorough hydrological survey and made the city a proposal to put a well down near the main pumping station, install a deep-well turbine pump and guarantee under a surety bond to produce five hundred gallons more per minute than the supply at that time. A committee from the city investigated the Layne system at Camden, N. J., where a number of units have been in operation for several years, and on their favorable report a contract was entered into on the above basis.

A location was selected about 300 feet from the 8-inch deep well and about 200 feet from the nearest flowing well. The equipment sent to perform the work was entirely different from any ever seen in this locality. Rotary drills were used exclusively. A 10-inch hole was drilled to ascertain the nature of the stratification and location of any water bearing sands. Shell rock of an extremely hard, crystalline nature was found at seven different locations at from 90 feet to 182 feet, varying in thickness from 6 inches to 4 feet.

No water bearing formations of a character satisfactory to the Layne engineers was encountered until the depth of 192 feet was reached, where 30 feet of fine sand was penetrated. Blue clay was found below this sand for a depth of 80 feet and at 302 feet a second stratum of sand 48 feet deep was penetrated. No water bearing sand was found below this that was desirable.

In developing the supply a 42-inch hole was rotated to 90 feet and in this was set a 38-inch Armco iron casing, sealed with impervious clay on the outside. From 90 feet to 190 a 30-inch hole was rotated through the rock and clay strata and 24-inch casing set. This casing extended to the surface of the ground. Inside this a 23-inch hole was rotated through the clay and sand strata and an 18-inch shutter screen set opposite the sand stratum and an 18-inch casing from the screen to the surface.



DISCHARGE FROM NEW WELL AT KINSTON

Sand and mud were removed from the water-bearing stratum and replaced with a uniform-size round filter gravel. This combination of shutter screen, special filter gravel and natural sand formed a vertical filter 300 feet below the surface of the ground, with a filtering area at point of separation of approximately 490 square feet.

After the development had been completed, a Layne deep well turbine pump directly connected to a Westinghouse vertical motor was installed, and pumping tests show a capacity of 871 gallons per minute with a draw-down of 46 feet or a specific capacity of nineteen gallons per foot of draw-down.

Work was begun on the contract in March 1926. The 90 feet of 38-inch casing had been set and the 30-inch hole about completed through the rock and clay, when some drill parts were lost, and before these were extracted, one of the rock layers shifted and the entire hole was lost. The equipment was moved about 15 feet, and a second well drilled. The work was completed in December, 1926.

The total contract price, including pumping equipment installed, was $29,000. The cost per gallon was $33.33 as against over $400 per gallon by the old method.

On first thought, $29,000 for one well may seem high, but considering that the contractors guaranteed 500 gallons per minute or no pay and that the cost per gallon was far less than by the old methods, it proves to be very reasonable.

Kinston is now assured that sufficient ground water can be developed by this system to supply the city, no matter what its growth or what industries may come there, and have assurance of abundant water at low cost.

Culvert Costs in Montana

Alternate bids on corrugated metal and reinforced concrete culverts on the Flint Creek highway, Granite County, Montana, were made as follows for the low bidder, J. N. Brown & Son, Bozeman, 240 feet of 15-inch and 182 feet of 18-inch corrugated metal culvert, $1.35 and $1.55 per foot respectively; 441 feet of 15-inch reinforced concrete pipe culvert, $2.00 per ft.; 100 feet of 24-inch corrugated metal, $2.25 per foot; 102 feet of 21-inch reinforced concrete, $2.25 per ft.; 138 ft. of 18 and 24-inch corrugated metal syphon, $1.85 and $2.75 respectively; 141 feet of 15 and 21-inch reinforced concrete syphon, $2.75 and $3.75.

Approximately the same relation of prices existed on bids for the Yellowstone Trail, Missoula County, on which Buck Helean, Missoula, was low bidder. The bid on 18-inch corrugated metal pipe was $1.60 per foot and on 15-inch reinforced concrete, $2.25 per ft.; on 24-inch corrugated metal it was $2.50 per foot and on 21-inch reinforced concrete, $3.25. On the Taft-Borax highway, Mineral company, Sam Orino, Spokane, Wash., low bidder, the prices were $2.20 per foot for 18-inch corrugated metal, and $2.50 per foot for 15-inch reinforced concrete. In each case the smaller size of reinforced concrete culvert was calculated to be of approximately the same carrying capacity as the larger size of corrugated pipe.

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CONTENTS

Sub-soil Capillarity

Capillary attraction is a wonderful, and to many an unsuspectedly powerful, force of nature. Acting in soils it is most essential for the farmer, but it can sure be a nuisance to the engineer. Let clay of the proper texture absorb water, and it will raise street pavements en masse, will force curbs away from pavements and perform other dislocations of supposedly permanent structures. When, on drying out, the clay shrinks in volume it may open in cracks two, four, or even six inches wide, and by adhesion to the pavement above crack this also. Later the clay on one side of this crack may swell more than on the other and a vertical break in the pavement surface occurs. Or the sand cushion sifts down into the crack and allows the paving blocks or bricks above to settle out of the surface.

These and other performances of clay, "gumbo," and similar soils are reported from Canada to the Gulf of Mexico, as told in the first few pages of this issue. Here also are described measures taken to prevent or remedy these destructive effects.

Most of the remedies may be divided into five classes: Providing a concrete base strong enough to resist the force of the soil in contracting or expanding. Laying the pavement on a dry soil, and preventing water reaching it. Laying it on a wet soil and preventing this from drying out. Mixing stone, gravel, etc., with the top layer of the soil to break up its homogeneity and largely eliminate capillary action and prevent wide cracks. And placing a layer of granular material between the soil and the pavement to prevent motions in the former communicating themselves to the latter. Each of these has been tried with both successes and failures, but probably the last has registered the most successes.

About a third of the engineers replying to our questionnaire stated that they had experienced troubles of this kind, and probably many others might have done so; so that the subject is one of quite general interest. We therefore have no apologies to offer for the space devoted to the subject in this issue. Rather, we think ourselves fortunate in being able to obtain so much first-hand information on the subject and so many descriptions of experiences and successful remedies which should be of great assistance to other sufferers from subsoil capillarity.

New Sources of Water Supply

In the East, already, in certain sections, all available surface water supplies are pre-empted; in some sections of the middle West and the South, industrial wastes were rendered unfit for use as water supply, many surface sources. Of course it is possible to treat or otherwise dispose of many of these contaminating or polluting wastes, but the fact remains that in some sections new sources of supply must be found. From our present knowledge, we can look to only one source, ground supplies. It has long been held by a number of engineers that we have lagged in this field, that springs, wells and filter gallery construction will often yield better and cheaper supplies. Abandoned mine galleries usually pro-

vide excellent supplies, occasionally high in minerals, which is a characteristic of nearly all ground waters; but frequently minerals are cheaper and easier to remove than are the impurities so generally found in surface waters. As a rule, the deeper ground water supplies are more constant and uniform in quality than surface supplies, and frequently their cost will be less.

At present, engineering knowledge in regard to ground water supplies seems to be limited. In many sections of the country where extensive drilling operations have been carried on, considerable information is available; but generally such data are so meager that the consulting engineer, engaged in seeking a water supply for a community, passes by ground water supplies as unavailable because he knows little of them. But it seems that they would be worthy of investigation, even at some cost, in the case of a smaller community, or for an additional supply for a larger one.

Books and Libraries

The doctor and the lawyer to be successful must, as a rule, maintain a pretty complete and up-to-date library. Few engineers seem to feel that the purchase of books is a necessity, but rather the majority of them appear to take the attitude that experience is the best teacher. In this day when most engineers specialize rather narrowly, the cost of a complete library is small; even for the city engineer, who covers a pretty wide field, the cost of a well selected library would be surprisingly low; and to keep supplied with all latest texts, once the library was completed, the cost would be almost insignificant.

It has always seemed to us that too little stress is laid in this matter in engineering schools. Progress of an engineer in his profession depends very largely upon continuing his study after graduation. Unless he studies faithfully and continuously, the engineering graduate soon loses his advantage over the non-graduate engineer who is willing to study.

For Control of Correspondence Schools

The National Correspondence School Committee of the American Association of Engineers finding that "our country is overrun with correspondence schools that, by misleading advertising and misleading circular matter are robbing young America of millions of dollars per year," has prepared a bill to curb such schools and this bill is being introduced to the various state legislatures and it is expected ultimately to introduce it in Congress. This bill would make it "unlawful to establish, conduct or maintain a correspondence school, or to carry on or conduct correspondence school work, without first obtaining a certificate from the Department of Registration and Education and otherwise complying with the provisions of this Act." Such school must make application to the Department of Registration and Education for permission to operate, and the department will decide whether the school complies in all respects with the provisions of the Act and may call for additional information, examine books, records and papers, and require any of the officers or agents connected with the school to furnish additional information. A certificate would be good for one year only and would be reissued each year thereafter during good conduct. The department could at any time revoke the certificate for violation of any of the provisions of the Act or of the rules and regulations of the Department. The charge for the certificate would be $100.

Among the requirements for a certificate would be that the correspondence school be duly incorporated under the laws of the state or of some other state or of the United States; shall have a paid up capital stock of not less than $50,000, and satisfy the department that it is solvent and able to carry out its financial obligations; shall offer instruction or training that is adequate, suitable and proper for the announced purpose of each course; possess sufficient and proper facilities for conducting its courses, correcting papers and other materials submitted by students, and for furnishing the student competent assistance; have a resident staff of examiners and instructors who are qualified to successfully conduct the work entrusted to them, at least 75 percent of all such work to be handled by the resident staff; and such other essential qualifications as the department may prescribe. Annual reports to the department are provided for, and fines for operating without a license or for representing that a school has a license when it has not.

Bureau for Traffic Study

There has recently been established in Harvard University the Albert Russell Erskine Bureau for Traffic, which proposes to make extensive investigation of traffic problems in American cities and to publish from time to time the results of these findings.

Last year the Chicago Association of Commerce secured the services of Dr. Miller McClintock, director of this bureau, to make an engineering study of street traffic conditions in that city, and suggestions for a comprehensive traffic plan and a uniform code for the Chicago metropolitan area. A request for such study had been made by the city council, and a committee representative of the important traffic interests of the city was appointed which secured the services of Dr. McClintock and an appropriation of $50,000 was made by the Chamber to further its project. The report published by the Chicago Association of Commerce embodying the results of this study and entitled "Report and Recommendations of the Metropolitan Street Traffic Survey' is of great value not only to Chicago but to all students of this subject.

Sanitary Engineering Positions Open

Two experienced sanitary engineers are needed by a large organization. One position in northern South America requires a man skilled in water supply and purification, sewerage, sewage disposal, and drainage and mosquito control; the other position in India, requires a knowledge of drainage, mosquito control and general engineering. The pay for either position is about $6,500.

"Water Dogs" in a City Water Supply

Salamanders eight to twelve inches long in mains, bred in reservoir, prevented by screening reservoir.

By R. A. Polglaze*

For several years the water consumers of an Alabama city of about 40,000 population have been finding in the water "spring lizards" or "water dogs." At frequent intervals during each year complaints regarding these "animals" would come to the office. These complaints were not confined to any particular season of the year, but were rather more numerous in the spring. The causes of complaints were varied. A plumber, called to investigate a pipe stoppage, would find a "water dog" jammed in the pipe. The Fire Department would report finding them while flushing fire hydrants. The street department operated a motor-driven street flusher, into which the "dogs" would be drawn from the hydrants; sooner or later, one or more would clog the flushing nozzles, which would be taken off at the city hall for cleaning, and the dog or dogs removed, and frequently placed on display, much to the embarrassment of the local superintendent. Frequently the dogs would be found jammed in meters or corporation cocks.

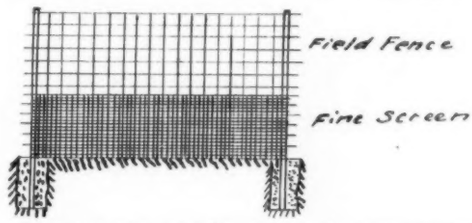
There were usually 15 to 25 complaints a year. Some consumers would complain bitterly at finding them, and carry their complaints to the County and State Boards of Health, or even threaten legal action. "Water dogs" became a campaign issue in the 1926 election. One candidate for Alderman put one in a bottle of alcohol, and carried it around in his pocket, declaring as his platform "water with the dogs left out." He was elected.

The animals found resembled lizards, but had outside gills, and varied in length from 8 to 12 inches. They were generally brown, or brown and white spotted. After some difficulty, they were identified as the tiger salamander, "amblystoma tigrinum," or a near relation, "A. punctatum," the life history of which is as follows: Eggs are deposited in the early spring in shallow water in large jelly-like masses. In a short time these hatch to tadpoles, with branching gills at the side of the head, but do not become mature until the following year. During the tadpole stage, they live in water; as they mature, they lose their external gills, and become land animals, returning to the water only to lay eggs. The adult is carnivorous, living on insects, snails, worms, etc., while the tadpole is a scavenger or eats vegetable matter only.

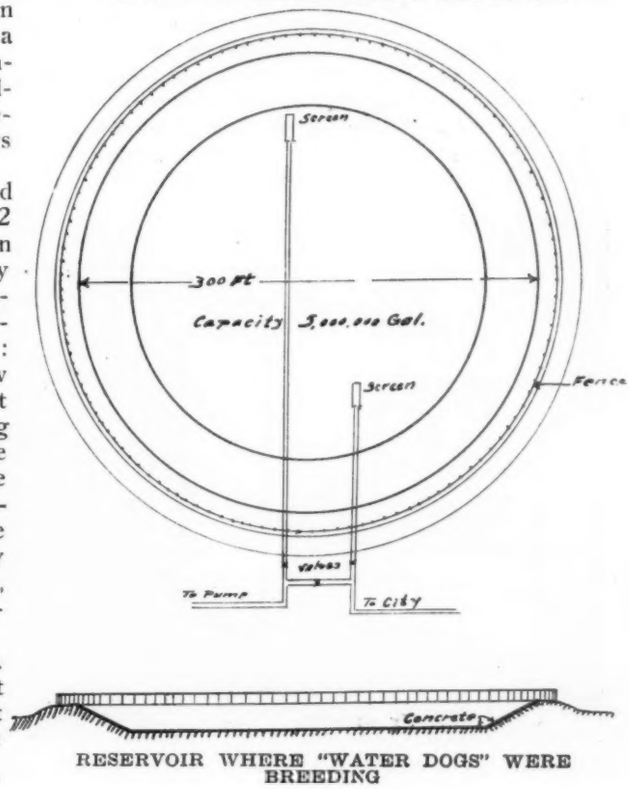
The water for the city is obtained from a large spring which normally would flow about 2 million gallons a day, but can be pumped at a rate of 6 million gallons without lowering the level more than 12 feet. The water comes from a lime rock foundation, rising to the surface through a large irregularly shaped crevice. The main part is roughly circular, about 30 feet in diameter, and extends vertically downwards 35 feet, becoming then more irregular, and extending down at an angle of about 60 degrees to an undetermined depth. The water is pumped from the spring by a 4-million gallon Worthington centrifugal pump into a 5-million gallon reservoir.

The reservoir is of "cut and fill" type, lined with concrete, and uncovered. The water is carried to the city, four miles distant and 200 feet lower, through two 14-inch mains. The entire spring basin is enclosed in a house. The water is generally of very good quality and receives no treatment except chlorination.

Some time previous, the suction pipe at the plant and the outlet pipes at the reservoir had been screened with heavy galvanized wire of half-inch mesh. As every animal found was too large to get through this screen, the theory was advanced that they were breeding in the mains, or were being pumped into the distribution system in the egg stage, and then developing. A peculiar characteristic was that no small ones



SECTION OF FENCE AROUND RESERVOIR



RESERVOIR WHERE "WATER DOGS" WERE BREEDING

* Polglaze and Basenberg, Consulting Engineers, Birmingham, Ala.

were ever found, which seemed to disprove both theories.

A careful examination of the reservoir showed conclusively that the animals were breeding there. In fact, several species were found, thus accounting for the fact that complaints were not common to any one season. The conclusion was finally reached that the "dogs" were getting into the distribution system while still small enough to go through the half-inch mesh screen, but were, for a time, content to stay in the mains; but when the gills began to close and they were changing to atmospheric breathers, they were caught in the services or drawn from the hydrant while seeking an outlet to the air.

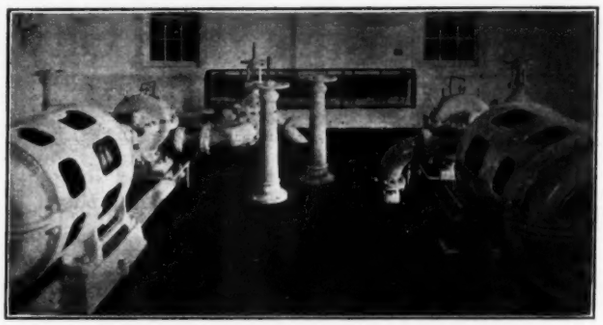
It appeared clear that the way to keep the "dogs" out of the distribution system, was to keep adult ones out of the reservoir. A 56-inch fence, the bottom 30 inches covered with a quarter-inch mesh wire cloth, was built around the reservoir. A heavy screen with eighth-inch mesh was placed over the outlet pipes. The reservoir was cleaned and treated with copper sulphate to eliminate the food supply and to make it less desirable as a breeding place.

This work was completed in the spring of 1926, and there have been no further complaints.

Heating a Pumping Station by Electricity

Freezing of the pumps in the automatic pumping station of the town of Morristown, N. J., is prevented by the use of electric heat. The need of close control and the necessity for unattended operation eliminated the possibility of using fuel.

The pumping station, a brick building about 22 by 29 feet in size, is located at some distance from the town and is exposed to the elements on all sides. In order to prevent the pumps from freezing in cold weather, a total of 30 kilowatts of electric heating units was installed, the General Electric form G oven heaters being used. Six of these units are now in operation, connected two in series, 3-phase, Y, on 440 volts.



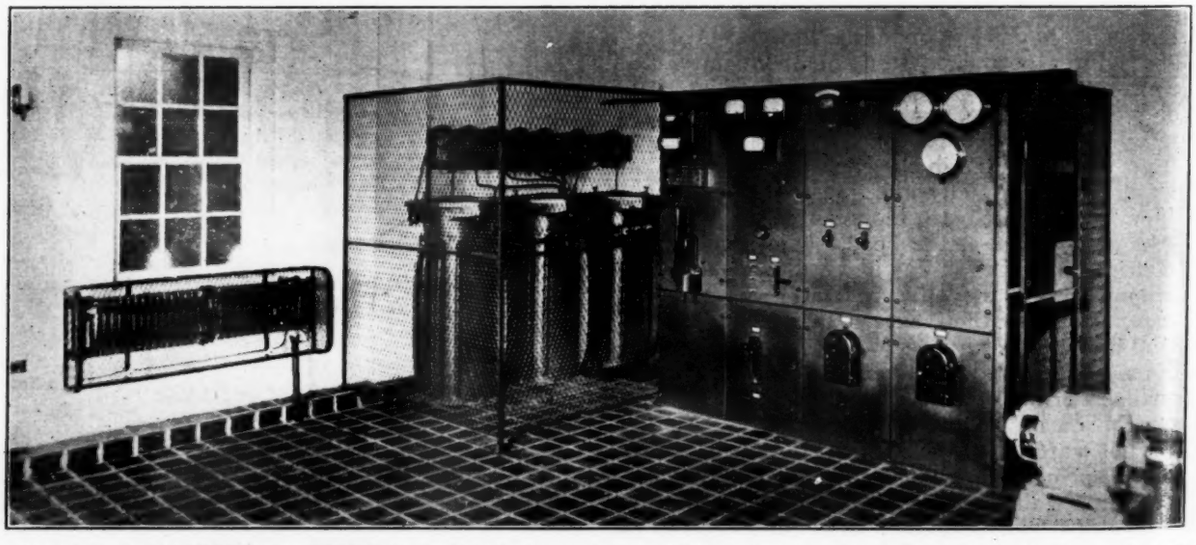
MORRISTOWN PUMPING STATION; HEATER ON REAR WALL.

The heaters, protected by a screen, are arranged along the north and east walls, near which the pumps and other equipment are located. The heaters are controlled with a standard automatic panel and Bristol temperature control instrument of the type ordinarily used with industrial ovens.

In order to secure the benefit of the minimum rate for power, it is necessary to cut out the heaters for several hours in the early part of the evening. With this in mind, the present installation was designed to maintain a temperature of 50 degrees during the day, as it was estimated that, during the period the heaters are cut out, the temperature in the station would fall about 10 degrees. The minimum outside temperature was estimated at 10 degrees below zero.

F. A. Hoffman, of the department of public works in the town of Morristown, says: "We have found that the cost of heating this building in the coldest weather we have had so far would average about $20 per month, including current at 1½ cents per kilowatt-hour. The automatic control device has operated perfectly."

Since the installation of this heating equipment, the idea has been adopted by the Jamaica Water Supply Company, Jamaica, L. I., and the Westchester Lighting Company, Mount Vernon, N. Y.



CORNER OF MORRISTOWN PUMPING STATION SHOWING 30 KW-440V-3 PHASE INSTALLATION FOR HEATING

Cleaning Water Services In Longueuil

In Longueuil, Canada, across the St. Lawrence from Montreal, the service pipes of the water system are found to be reduced in capacity by "a cumulative coagulation that is taking place after filtration and deposits on the inner surfaces of the pipes," according to Romeo Bourbeau, city engineer of that city, in an article in "The Municipal Review of Canada." Half-inch pipes are found reduced to an effective diameter of one-eighth inch. The method of remedying this is described by Mr. Bourbeau as follows:

The process consists in washing by circuits; that is, to shut the valves of a limited area and open its hydrants for the wash water to flow out. A 128 cu. ft. compressor mounted on a truck, equipped with 100 ft. of hose, and delivering air under 100 lbs. pressure, is connected to the kitchen tap, and is allowed to run for about one-half minute, the behavior of the motor telling that the pipe is then free of all attached sediments. The hose is then disconnected from the compressor, a small handfull of screened dried sand is poured into the hose with the help of a small funnel, the hose reconnected, and the compressor allowed to run for about two minutes. The grit of the sand makes it so that lead pipes after this treatment look just like brand new pipes. After about the first half-minute of this second operation, men go from tap to tap leaving them open a few seconds for the sediments to come out. Then the hose is pulled to the nearest house, perhaps on the opposite side of the street, and the work resumed. After the least training the men will not take more than six minutes per house, if a proper comparative record is kept and shown to them at intervals, creating a certain emulation. When the whole limited area is finished, one valve is opened to flush the sediments through the furthest hydrant, then this valve is shut and the one at the opposite end opened, flushing at the first extreme hydrant. Then all hydrants are shut gradually as all valves are opened. With the co-operation of our water works superintendent it was arranged that no time was lost transferring from one circuit to another, causing quite a low cost. It is most important that during the operation a man be kept holding the ball cock of the W.C. or of the heating system, so that no air nor sand will collect in the tiny piping.

The cost of the compressor was $30 per day with the operator, and three attendants at $3.50 each were all that was necessary with the man in charge. Six hundred and fifty-three water connections were treated that way at a cost of 59¼c per service, including interior house pipings. This can be compared with the cost of excavating, or even using pressure pumps with their risks of bursting.

Asphalt Maintenance Without Recourse to Large Plants*

Small repair plants for preparing hot mixtures, and materials that can be laid cold, available for small cities. Cut-back and emulsified asphalts. Equipment for patches and small jobs.

By Walter E. Rosengarten†

It is estimated that in this country there is in the neighborhood of six hundred and fifty million square yards of mixed types of asphaltic surfaces. If the maintenance and patching area is 1% per year it means that some six million five hundred thousand square yards are laid annually in small and scattered patches, numbering probably a million. While it may seem a trivial matter to discuss the patching of a small opening, it is indeed a big proposition in the aggregate, and if it can be properly and expeditiously accomplished it means a comfort and service to the traveling public.

In the Borough of Manhattan, New York City, during the year 1925, openings totaling 78,532 square yards were cut in the asphalt pavements for work on underground structures. This is a little over 1 % of the total area and is typical of the condition throughout the country. An English writer has called this "trench fever." It is indeed a contagious and expensive disease, but there is little wonder when it is recalled that beneath our pavements is a network of water, gas, electric, telephone, sewer and steam lines. Frequently the number of openings is increased due to indefinite mapping of these structures. An endeavor should be made wherever possible to so lay out underground pipe lines and services as to eliminate the necessity of openings in the paved area. A central park area in the wider streets is an ideal location for pipe lines. Some localities have laid piping under the sidewalks, and a worthy suggestion has been to make the curb a box conduit for electric services and small pipes. The street lighting would very conveniently be served in this manner.

In relaying the pavement a rule which should be followed is that the materials and construction should be as near like the surrounding pavement as is possible. If this is done there is less likelihood of a bad place forming and the existence of the patch will also be less noticeable.

For the larger cities which have their own asphalt plants or have sufficient work to keep a contractor with a hot-mix plant in continuous operation, the question of repairs is not so difficult. For the small city, where a hot-mix plant is not available, the question of properly repairing openings is some-

*Extracts from paper before the Fifth Annual Asphalt Paving Conference.

†Traffic Engineer, The Asphalt Association, New York, N. Y.

times considered a more difficult problem. This should not be the case today, when there are available small repair plants for preparing hot mixtures, as well as asphaltic materials which can be handled cold.

The problem which confronts the engineer or official in charge of maintenance of asphalt surfaces of the hot-mix type is the fact that patches and repairs are required at odd times and must be laid in small areas. The quantity of material required at any time does not justify setting up and starting in operation a full-size hot-mix plant. Repairs in a sheet asphalt or an asphaltic concrete pavement should preferably be made with a hot-mix of a similar grading and a slightly harder asphalt than that used in the original construction. There is no need for an opening to be left unpaved for any period, as a temporary patch can readily be placed. This may be of penetration type, or preferably a mixed type. Cold asphaltic binders may be used for this purpose.

COLD MIX MATERIALS

The asphalt binders which can be mixed cold at ordinary temperatures may be classed into cut-back asphalts and emulsified asphalts. There are also on the market ready prepared asphaltic mixtures which can be laid cold.

The cut-back asphalts are made from standard grades of paving asphalts which have been softened by combining them with a light petroleum product, such as naphtha or gasoline. These are workable at ordinary temperatures. About two-thirds of a gallon is mixed with a cubic foot of stone chips to form a paving material. It may be kept in stock piles for long periods and when needed can readily be spread out on the road surface in a thin layer. Initial stability is obtained through the mechanical interlocking of the aggregates when rolled. The light, volatile material then evaporates rapidly, leaving the hard, sticky asphalt to bind the mix firmly in place and thus insures the necessary stability for modern traffic. If desired, these materials can easily be prepared on the job, the mixing being accomplished either by hand or in a small portable hydraulic cement mixer. A satisfactory method is to stock the materials at the department yards and provide a covered place where mixing can be done on rainy days. It is preferable to allow the material to stand for a short time after mixing to stiffen somewhat so that it will hold its place better when first spread on the road. A material suitable for this work is covered by the following tentative specification, which has been carefully prepared by the Asphalt Association:

Cold Patch Asphalt
Specification M-1, Jan. 12, 1926

The cold patch asphalt shall be homogeneous and free from water. It shall meet the following requirements for physical and chemical properties:

1. Specific viscosity Engler at 122° (first 50.cc) 30 to 70.
2. Separation of Asphalt Base from Distillate Flux.
   a. Distillate by volume
      Per cent. off at 374°F.....not less than 10
      Per cent. off 437°F.....not less than 15
      Per cent. off at 680° F.....not more than 35
   b. Characteristics of residue from distillation to 680°F.
      Penetration at 77°F., 100 g., 5 sec.....50 to 150
      Ductility at 77 F°.....not less than 30
      Per cent. bitumen, soluble in CS .....not less than 99.5
   Methods of Testing.
      Specific viscosity Engler, U. S. Dept. of Agriculture, Bulletin 1216, P59.
      Separation of Asphalt Base from Distillation Flux (Special method issued by the Asphalt Association)
      Penetration, A. S. T. M. Standard Test D5-25.
      Ductility, A. S. T. M. Tentative Test D113-22T.
      Bitumen, soluble in CS, A. S. T. M. Tentative Test D4-23T.

The second class of asphaltic materials for cold working are known as emulsified asphalts. These are prepared by treating ordinary paving asphalt with a saponifying agent so that it will mix with water. These emulsions contain about two-thirds asphalt and one-third water. They are handled in a manner similar to the cutback asphalts. It is not necessary that the aggregates be dry when mixed with emulsified asphalts. About one gallon is used for each cubic foot of aggregate. The latter can be made up of two-thirds of ¾-inch stone and one-third clean ⅜-inch screenings. The small inclined axis type of mixer gives better results and

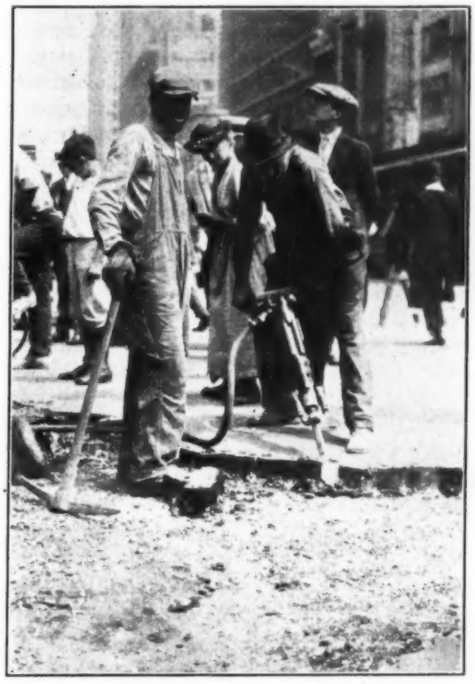
SHEET ASPHALT REPAIR GANG AT WORK IN TORONTO, CANADA

less trouble from balling than the horizontal axis mixing machines. Care must be used not to overmix when this material is used, as there is a possibility of the water and asphalt separating. Until recently, freezing also would damage emulsified asphalts by causing their separation. However, a material is now on the market which overcomes these disadvantages and can withstand freezing weather without injury. This material has been carried through the winter without impairment. The emulsified asphalts are excellent for cold patching work and, while it is recommended that a hole be cut with vertical edges to more securely hold the new material in place, many successful patches have been made by lightly painting the surface of a depression, or disintegrated spot, with emulsified asphalt and filling with a mixture of stone and emulsified asphalt which is spread to a thin edge.

Ready mixed materials are available, which makes unnecessary mixing plants and machinery other than the shovels, rakes and tampers or rollers. These are generally mixed at quarries or central mixing plants and shipped in carload lots. They may be stored in stock piles and used as needed. Old asphalt pavement is sometimes re-used for temporary patching. It is broken into small pieces of 2-inch to 3-inch size and heated in kettles with about 5% of water. It is allowed to steam for half to three-quarters of an hour and the plastic mass then is spread in the opening and compacted. This practice is used in several of the larger cities for winter patching. Some places pass the old material through an asphalt plant and add fresh asphalt or sand as needed to improve it.

It should be considered that these cold mixtures and reheated materials make very satisfactory temporary patches to hold for a time. When sufficient patching of this character has been carried out it is desirable to arrange for a hot-mix plant to come in and replace the temporary patches. This requires additional cost, but it is compensated by the fact that no period of obstruction to traffic need exist. The more lasting hot patch of carefully graded aggregate will blend more rapidly with the surrounding pavement, making it practically unnoticeable after traffic has passed over it for a short period It is possible by the use of suitable equipment to make hot-mix patches for small areas.

Since it is desirable to replace an opening as promptly as possible, some cities have been successfully cutting down the period of obstruction to traffic by constructing the base of asphaltic concrete in place of Portland cement concrete. It is laid in courses of not over 4 inches, each thoroughly



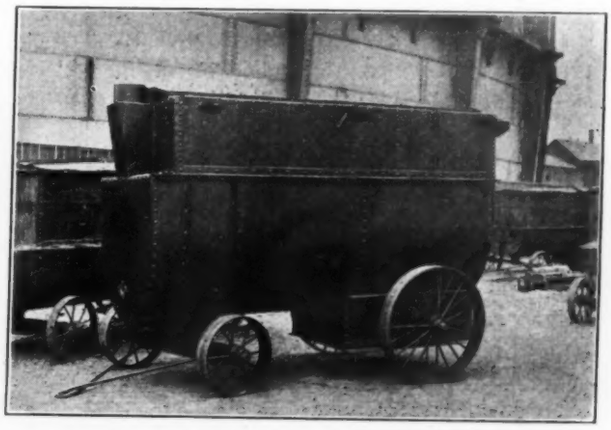
CUTTING OUT ASPHALT PAVEMENT IN NEW YORK CITY

tamped. On this the surface is immediately placed by the same gang laying the base, using the same equipment.

EQUIPMENT FOR MIXING

Contrary to the general opinion, excellent patching of the mixed asphaltic pavements can be accomplished with inexpensive equipment. Materials can be mixed by hand and little more than a mixing board, shovels, rakes and tamps required. When a few square yards are patched at infrequent intervals, as in small towns where but a few streets are paved, creditable work can be done with this simple outfit. Of course it is desirable and economical to have additional equipment if any appreciable area is to be maintained.

PATCHING HOLE IN WASHINGTON, D. C.



1500-GALLON PORTABLE MELTING KETTLE

A variety of equipment is on the market which will suit almost any need. For heating the asphalt there are a number of small portable kettles burning wood or oil. Aggregates may be heated over pipe containing fire, but there are small portable heaters for this purpose. A compact portable maintenance outfit which is being used extensively includes a body with compartments for sand, stone and asphalt, a heating furnace and a hand-mixing pan. With this a gang of four men can patch about 80 square yards per day. For cold weather work a special wheelbarrow equipped with gasoline heating torch, in which hot materials can be mixed and transported, will be of assistance.

For mixing of the cold patch and emulsified materials the small concrete mixers may be used. For hot mixtures a compact, well equipped portable unit with open top continuous blade mixer, rotary sand drum heated by kerosene burners, air compressor, etc., operated by gasoline motor can be purchased for about $5,000. It can be operated by a mechanic and one laborer who can turn out 125 square yards per day. If the area to be maintained is large, a small size, completely equipped, portable asphalt plant will undoubtedly be desirable. Several plants of this character having outputs of from 350 to 800 yards per day, are on the market at a cost of $7,000 to $12,000. Generally they are mounted on a rubber tired trailer for easy transport. Heat is furnished with fuel oil burners and power by a gasoline motor.

A handy piece of equipment for maintenance work is the surface heater. This consists of a hood which confines and directs hot gases upon the pavement. After a few minutes the old surface is sufficiently soft so that it may be scraped to a depth of ¾-inch and new material applied. In this way humps and depressions may be leveled and disintegrated places renewed with the use of a very small amount of new material. The surface heater may be obtained in several sizes, the smaller machines mounted on two wheels and hand propelled, while the larger ones are on a truck or tractor chassis.

In concluding, it is well to reflect that a few cents spent on maintenance and repairs is not wasted, as it is certain to prolong the life of the pavement and thus return to the community several fold. It will also give a smoother riding pavement and thus serve its purpose to better advantage. If we consider a sheet asphalt surface costing $1.50 per square yard to have a life of 20 years, the cost for principal and interest to be paid off during its life is 12 cents per square yard per year. The average cost of maintenance for such a pavement may be taken at about 2 cents per square yard, making a total cost of 14 cents, or $2.80 for the 20 years period. By doubling the maintenance it would be quite possible to extend its life 50% or to 30 years. The additional maintenance cost would be 60 cents per square yard. As against this a renewal of the pavement, at the end of the 20 years would cost 14 cents per square yard per year, or $1.40 for the ten years. Thus the additional maintenance would effect a saving of 80 cents per square yard. Adequate maintenance cannot merely be considered as upkeep. It builds additional life into the pavement.

Ambitions of the American Road Builders' Association

"The American Road Builders' Association must do more than run a convention and a machinery exposition in order to justify its future existence, present organization and commitments." This decision of the Fiscal Committee of the American Road Builders' Association was submitted by it to the Board of Directors at its meeting on January 12th and is to be presented at the annual meeting in May for definite action. This report has been made after conferring with committees of the American Association of State Highway Officials and the Highway Industries Association.

The committee "earnestly urges that the prominent feature in the coming year's activities be the promotion of highway safety. This is one of the most serious situations with which the nation has to deal today. It is also one of the most important problems confronting the highway industry and particularly those men who, by the construction of modern highways, are responsible for the safety of the millions who travel them." In conjunction therewith, there can be carried on "a theme of publicity which will, at the same time, assist in building a "good road consciousness" in the children whom we wish to protect as well as in the nation at large.

The next point submitted is "the appropriation toward a fund enabling the association to encourage the visits of selected foreign engineers to this country for the study of American highway methods. A practical plan can be worked out for the selection of these men from those countries offering the greatest opportunity for highway development.

"This committee, representing the American Road Builders' Association, recognizes the great value in the work being carried on by the American Association of State Highway Officials. In appreciation of this work, it recommends that the American Road Builders' Association make a contribution, so long as their funds will permit, of $2,500 annually to the American Association of State Highway Officials for use in its activity in highway development."

The committee also recommends that, in view of the proposed removal of the headquarters of this association to Washington, D. C., it offer additional help to the industry through the development of a library service.

The budget prepared for covering this program totals $47,800 for 1927, of which $22,000 is for salaries of the present organization, and $8,000 for the safety campaign. The income is estimated at $42,000 from the Road Show and membership dues; but the society already has a surplus of $31,300 to draw upon. However, this surplus would last only a few years with the proposed rate of expenditure and some method for raising the additional $5,800 a year will have to be devised.

"In view of the resolution passed by the Board of Directors at its meeting in Philadelphia on October 20th, 1926, no provision is made in this report for further publishing the catalogue directory."

The Fiscal Committee is composed of Paul L. Griffiths, Chairman; R. Keith Compton, J. H. Cranford, Chas. M. Upham, W. R. Neel.

Pavement Design in Relation to Traffic*

Deciding upon width of roadway for various traffic conditions. Street railways; crown; grades—all need careful planning. Zoning streets for traffic.

By Edwin A. Fisher†

WIDTH OF ROADWAY

First. Consider the width of roadway in existing streets the total width of which it is not proposed to change; and second, new streets, or streets where it is proposed to change the total width.

Formerly the width of roadway was generally taken as a percentage or porportion of the total width of the street.

The residence streets in the city of Rochester are generally three rods—49½ feet—or 60 feet in width. Many of the main thoroughfare streets are four rods—66 feet—in width. A few, six rods.

The writer some years ago, when city engineer, fixed the minimum width of roadways in residence streets at 26 feet. The Council later reduced this width generally to 24 feet. Twenty-four or 26 feet answers the purpose very well with horse-drawn vehicles and with no parking at the curb. The minimum width of streets having double-track railways was at the same time fixed at 38 feet. The distance from center to center of tracks is 9 feet 8½ inches. The car bodies are about eight feet wide over all, making the total width from out to out of the car bodies in round numbers 18 feet.

In a 38 foot roadway there would be left a width of 10 feet from the car body to the curb. This width was sufficient to allow standing room between an automobile and the car body. This width of 38 feet answered very well when the speed of the trolley cars was greater than that of the automobile and there was no considerable parking next to the curb. With the advent of fast moving automobiles, the speed of which was much greater than the average speed of the street car, and with numerous machines parked next to the curb, the fast moving automobile was relegated to the rear of the street car and could make no better time than the average speed of the car.

In the city of Rochester an amendment to the City Planning provision of the Charter was adopted in 1921 which made it the duty of the Superintendent of City Planning, with the approval of the Advisory Board, to fix the width of pavements or sidewalks before an ordinance for the pavement could be adopted. This amendment was adopted with the consent of the Common Council to prevent the passage of ordinances providing for widths of pavement having no proper relation to traffic conditions.

The minimum width for a single line of traffic has been fixed at eight feet. The maximum width required for passenger vehicles parking at the curb is six feet. The total minimum width between curbs having a double track street railway is 50 feet. A number of 66 foot streets have been changed from 38 feet or 40 feet to 50 foot roadways. This width roadway leaves sidewalks of eight feet. We believe that this arrangement is the best that can be made for streets of such width.

In residence streets having traffic in both directions of a considerable amount, the width of roadway should not be less than 30 feet. In new streets, or streets where it is practicable without undue expense, we recommend widths of 34 feet for the roadway, leaving 8 foot sidewalks in 50 foot streets, and 13 foot sidewalks in streets 60 feet wide. Where it is not practicable to acquire a 30 foot roadway I would recommend, in general, that the street be made a one-way street.

In new construction, a width of roadway in the double-track streets should be at least 56 feet. A good width of street for an ordinary business street, and one adopted by the City Planning Bureau, is 86 feet, leaving 15 feet for sidewalks.

A new main thoroughfare completed in 1924, over the abandoned Erie Canal, in Rochester, making a part of a thoroughfare through the business section of the city 100 feet wide, has a roadway, without tracks, 60 feet wide, leaving sidewalks 20 feet wide on each side.

A portion of the main street of the city for a length of about a half mile had a width of roadway of 50 feet. The total width of the street was 90 feet. The roadway has been widened five feet on each side making a roadway 60 feet wide and sidewalks 15 feet. This has been done at the almost unanimous request of the property owners, and completed to their very great satisfaction.

In New York, in 1923, a special committee of engineers consisting of the chief engineer of the Board of Estimate and Apportionment and an engineer from each of the boroughs, studied the question of whether it was advisable to change the width of all 30 foot roadways to 34 feet on residence streets. A majority of the committee recommended such change. The minority report, signed by the chief engineer of the Board of Estimate and Apportionment and the consulting engineer of Queens, dissented from the majority report and recommended that the previously adopted standard width of 30 feet be allowed to remain. The minority report was based on the following conditions:

The streets having this width of 30 feet are in general light-traffic residence streets. The chief engineer's of-

*Paper before American Society for Municipal Improvements.

†Consulting Engineer to the City of Rochester, N. Y.

fice, in order to reach a conclusion as to the width of roadways applicable to the varying requirements of the city streets, made the following classification:

Light traffic, composed of passenger vehicles, except busses and light delivery trucks, the maximum width of which is 5 ft. 8 in.

Heavy traffic, composed of trucks and other large vehicles of a maximum width of eight feet.

Mixed traffic, composed of the above types in varying proportions.

In arriving at the tentative conclusions, which were shown graphically, the following assumptions were made:

That in a street designed primarily for local use in residential or light business sections, a 30 ft. roadway is adequate for two moving and two parked lines of light traffic. Parked vehicles should stand close to, and parallel with, the curbs. Based on clearances which have been demonstrated as adequate for vehicles in 30 ft. roadways, the following clearances should be allowed as the minimum consistent with safe and efficient traffic operations:

Between curb and standing vehicles	0 inches
Between curb and moving vehicles	22 inches
Between standing and moving vehicles	22 inches
Between vehicles moving in the same direction	26 inches
Between vehicles moving in opposite directions	44 inches

A 30-ft. roadway would accommodate two lines of parked vehicles and two lines of moving vehicles with the clearances given.

A 34-ft. roadway would provide for four lines of moving vehicles.

The roadway of Fifth Avenue, New York, is 55 feet, sidewalks 22½ feet each.

The roadway on the new bridge from Philadelphia to Camden has a width of 57 feet and provides for six lines of vehicles. The tendency is to increase the width of the lane required for vehicles from eight to ten feet, and most highways are now built with a provision for a 10 foot lane instead of the former eight feet. In Rochester, as stated, we provide a minimum width of eight feet for a line of traffic, and on streets of considerable traffic in the business section of the city, such as the Lake Avenue Boulevard, we have provided a width of nine feet for each line. On East Avenue where the traffic is very heavy, a 10 foot lane is provided.

The International City and Regional Planning Conference which met in New York City April 20-25, 1925, devoted considerable time, under the heading of "Planning Problems of Town, City and Region," to the question of "Widths of Roadways." Arthur S. Tuttle, chief engineer of the Board of Estimate and Apportionment of the City of New York, in a paper entitled "City Planning as a Permanent Solution of the Traffic Problem," referring to the streets in the Borough of Manhattan and to the city plan developed in 1811, said: "In general the north and south streets traversing the borough longitudinally were given widths of 100 feet, while the east and west streets extending from river to river were made 60 feet wide, with an occasional width of 100 feet.

"The wider streets in the early days did not prove to be as attractive for business as was the case with the narrower ones where congestion in some degree was noticeable, and no more than 25 years ago a street width of 100 feet was actually deplored by an engineer who occupied a position of great responsibility in the municipal government and who ventured the opinion that the author of a plan providing for giving a street width of 100 feet was entitled to be hanged."

It was not until 1903 that the inadequacy of our present streets began to be realized.

Among the suggestions for a solution of the traffic problem given by Mr. Tuttle was the fixing of the roadway widths to conform to the types of vehicles which they were likely to be called upon to accommodate, and the widening of the existing streets, where practicable, or accomplishing the same results by the introduction of sidewalk arcades, with a corresponding widening of the roadway. Mr. Tuttle said: "To my mind there is no such thing as a permanent city plan for the active, progressive and growing city, and the congestion problem must be considered as being ever present and as taking on a new character from day to day."

Morris Knowles, chairman of the City Planning Commission of Pittsburg, Pa., in a paper, suggested, among other things, the segregation of the different kinds of traffic, not only by regulation, but principally by the design of appropriate facilities.

G. L. Pepler, past president of the British Town Planning Institute, and Dr. Joseph Brix, professor of the Technical High School, Berlin, Charlottenburg, had a very comprehensive paper on the subject of "Arterial Roads." In this paper they gave details of the widths or roadways, walks and tramways in England, France, Germany and some other European countries. They said the standard unit in England used to be eight feet but has proved insufficient on arterial roads. The Ministry of Transport adopted a general standard of 10 feet per vehicle.

In Germany the standard unit is 2½ meters (8 feet 2 inches); but in practice for arterial roads, nine feet. The authors recommend nine feet. They recommend roadways through commercial or industrial areas for six lines of vehicles, or a roadway 54 feet wide, and walks 20 feet wide. A total of 94 feet, with refuges for pedestrians at crossings.

STREET RAILWAYS OR TRAMWAYS

The authors referred to say: "The laying of tramway rails on a roadway is now generally condemned. Tramways should be laid on an independent track separate from the area reserved for general traffic. No other form of tramway than on a track separate from the roadway should be allowed on new arterial roads." This practice is contrary to the general practice in this country.

PAVEMENT CROWN

Another feature of pavement design in its relation to traffic is the crown of the roadway. Prior to the advent of the automobile it did not make so much difference if streets had a pretty heavy crown, and the pavement engineer in his effort to keep the roadway free of water made very liberal crowns, making it rather difficult to drive next to the curb. The crown of the street should be made as light as practicable, and substantially of the same slopes from the center to the curb, so that one part of the roadway would be as available for traffic as any other.

GRADES

In general, cities are now using an asphalt pavement. This pavement is especially adapted for streets of light grades, and may be used up to grades of at least six per cent. In grades of over five per cent it may be desirable to construct a block

stone or brick pavement for about half the width of the roadway, either in the center or at the sides of the street.

SUMMARY

1. A single line or unit of traffic should have a minimum width of eight feet.
2. The tendency, both here and abroad, is to increase this width from eight feet to ten feet, where practicable, on main thoroughfares.
3. On residence streets having some through traffic, provide for two lines of traffic and two lines of cars parked at the curb. For this purpose the width of roadway should be not less than 30 feet.
4. Main traffic streets through the commercial or industrial areas of cities, wherever practicable, should provide for six or eight lines of traffic.
5. The minimum street width should be 80 feet; the maximum width 110 feet.
6. Arterial roads connecting large cities may be of the super-highway type from 100 to 250 feet wide, and should pass around the business section of the large cities. Actual examples in this country, England, France, Belgium and Germany come within these limits.
7. The pavement crown should be the minimum required for drainage and generally not over a slope of one in 60.
8. *Resurfacing old streets.*—Don't have any fixed rule. Depend upon the pavement conditions in each case. Be sure the foundation is ample, and the crown not excessive.
9. Zone the streets for traffic. Prohibit trucking and heavy loads in parkways and main residence streets where other routes are available.

Reclaiming Corroded Poles

Most cities and even smaller communities, are replacing the old wooden poles formerly used for telephone, trolley and other wires and also for electric lights, with steel poles, generally of the telescope type—that is, a small pole at the top telescoped into a larger one, and this sometimes into a still larger one at the ground surface. An eastern city where metal trolley poles had been installed found that corrosion had seriously weakened many of them, this corrosion occurring on and above the shoulder formed by the telescoping of the pipe, which shoulder served to hold collections of dust and this in turn the moisture which caused the corrosion. This corrosion was found most often on the building side of the pole, extending upward from the shoulder about two inches and about two-thirds of the way around the pipe. One of the poles was so badly weakened that it finally fell and the Street Car company proposed to reclaim all of those that showed any sign of corrosion to prevent further occurrences of this kind. How this was done is described in "Oxy-Acetylene Tips," to which we are indebted for the description and the illustration.

Speed and durability were required of the repair job. Bronze rod was therefore used. Fig. 2 one after it had been built up. It proved easy to complete work on four poles a day, and since each cost $80 standing, the saving made by this reclamation process was all in all considerable.

At first thought one would suppose it would be difficult to prevent galvanic action between bronze and steel, but practice has shown that fears in this direction are unfounded.

Galvanic action is rapid only when there is a chance for lodgment of dust and little pockets for rain water to collect in and remain stagnant. Repairs on these poles were consequently made in such a way that all rain water would be cleanly shed from the repaired section. The lower part of the pole was also carefully repainted. It has been found advisable also to cover the lower part of the pole with concrete, as is shown in Fig. 3. This is done not to reinforce the pipe, but as a double safeguard against new corrosion at the ground line, where dirt and moisture always collect.

The heat of bronze-welding is not sufficiently great to cause the pole to sag during welding, unless the pole is badly weakend. Where corrosion is excessive, it is considered best to guy the pole.

In many cities it is likely that such reclamation work can be performed. It will mean a great saving to the owner of the poles, and should be profitable to the contractor. Everybody wins when waste is prevented.

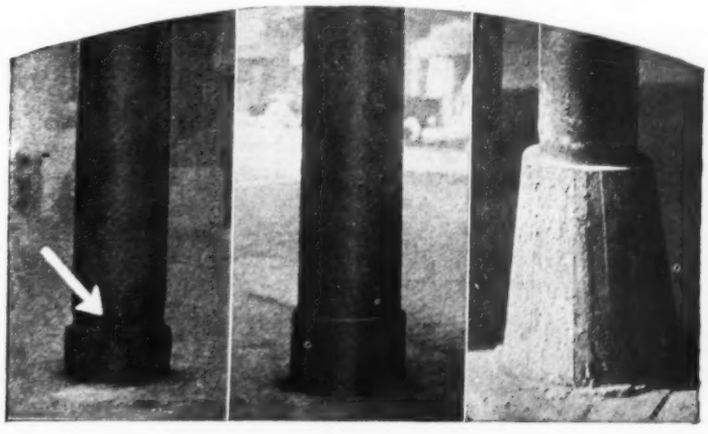


FIG. 1 — BEFORE BUILDING UP

FIG. 2—AFTER BUILDING UP

FIG. 3—CONCRETE COVERING

Patching Pavement Cuts in Wilmington

A method of patching pavement cuts was described by McKean Maffit, Superintendent of Waterworks, Wilmington, N. C., in a paper before the North Carolina Section of the American Waterworks Association. His method is to tamp the backfill in the hole as solidly as possible. For replacing the base, make a concrete mixture of the consistency of putty and tamp thoroughly until the tamping iron makes almost no impression. The top surface may then be put in place at once, covered with an inch of loose sand and thrown open to all ordinary traffic without danger of damage.

City Paving Done in 1926

Statistics from nearly eight hundred cities tabulated according to kind of pavement laid, giving the area and cost of each. Also data regarding cement sidewalks and the use of various kinds of joint fillers.

In compiling this year, for the nineteenth time, the statistics of paving done by municipalities in this country and Canada, replies were received from more than eight hundred cities, who through their officials have furnished this valuable information. Only the cooperation of these officials has made possible the publication of this data. In the case of a number of cities replies were received too late for inclusion in these tables, since some time is required to tabulate the information and set up the tables.

The questions asked this year were, in general, similar to those in previous years, but in addition information was asked concerning subsoil troubles, data concerning which will be found on pages 81-90, and in regard to the use of joint fillers and expansion joints.

Concrete Pavement Laid in 1926

	Reinforced Concrete			Not Reinforced	
	Amount Sq. Yds. or Miles	Cost	Reinforcement Wt. per 100 sq. ft.	Amount Sq. Yds. or Miles	Cost
Alabama:					
Birmingham	.....	.....	.....	168,728	375,134
Dothan	24,000	70,000d	40 lbs. Mesh	.....	.....
Opelika	.....	.....	.....	100,220	177,624b
Arkansas:					
Fayetteville	15,000	41,000e	Mesh & Bar v	2,000	4,500e
Hot Springs	.....	.....	.....	67,000	200,000
Little Rock	49,790	.....	.....	15,070	.....
Pine Bluff	21,000	.....	.....	.....	.....
California:					
Berkeley	.....	.....	.....	34,093	114,666
Glendale	.....	.....	.....	6.87 mi.	436,542a
Los Angeles	.....	.....	.....	2,314,980	5,233,612f
Monterey	.....	.....	.....	10,000	1.89-1.98s
Napa	.....	.....	.....	3,540	7,188
Newport Beach	.....	.....	.....	267,000	598,000f
Oxnard	.....	.....	.....	30,565	1.89s
Pasadena	.....	.....	.....	12,848	27,933
Pittsburgh	.....	.....	.....	4,000	8,050
Redwood City	.....	.....	.....	58,147g	101,295
Roseville	.....	.....	.....	1,333	4,200
Sacramento	6,025a	11,456	.....	.....	.....
San Bernardino	.....	.....	.....	118,505	162,589f
San Francisco	.....	.....	.....	44,143	126,952f
San Mateo	.....	.....	.....	16,728	63,269
San Rafael	.....	.....	.....	11,891	24,772
Santa Monica	.....	.....	.....	4,436	8,765
Sausalito	.....	.....	.....	44,444	100,000h
Vallejo	.....	.....	.....	5,704	10,971
Colorado:					
Denver	.....	.....	.....	187,125A	376,051F
Grand Junction	.....	.....	.....	893a	2,588
Greeley	.....	.....	.....	19,190	44,354a
Pueblo	.....	.....	.....	4,192	.....
Sterling	2 mi p	.....	.....	.....	.....
Connecticut:					
Hartford	3,231	14,455	30 lbs. Fabric	.....	.....
Meriden	.....	.....	.....	728	1,638
New Britain	4,100	19,000a	.....	.....	.....
Delaware:					
Wilmington	.....	.....	.....	3,000	10,500
District of Columbia:					
Washington	.....	.....	[illegible]	259,238	803,796a
Florida:					
Jacksonville	.....	.....	.....	19,600	61,500
Lake City	.....	.....	.....	79,877	241,393i
Georgia:					
Americus	1,000	.....	.....	.....	.....
Rome	.....	.....	.....	5,000	.....
Illinois:					
Alton	27,911	103,130	.....	.....	.....
Batavia	36,000	.....	40 lbs. Fabric	.....	.....
Canton	5,100	23,000a	.....	.....	.....
Champaign	26,000	324,000	.....	.....	.....
Chicago	.....	.....	.....	1,809,210	.....
De Kalb	39,475	126,541a	40 lbs.	.....	.....
East Alton	22,300	74,000	No. 2 wire 6x12 mesh	.....	.....
Edwardsville	6,050	20,800	3 lbs. Bars	.....	.....
Flora	20,000	110,000	.....	.....	.....
Flossmoor	17,908	71,508a	Bars	3,191	9,500a
Freeport	50,000	325,000	.....	.....	.....
Geneva	10,000	.....	40 lbs. Fabric	.....	.....
Granite City	10,000	30,000b	35 lbs. Bars	.....	.....
Joliet	5,500	21,800a	.....	.....	.....
Kankakee	141,132	429,240	.....	.....	.....
Kewanee	43,183	174,243	.....	.....	.....
Lake Forest	.....	.....	.....	1,188	4,965a
Metropolis	1 mile	30,000	.....	.....	.....
Mt. Vernon	31,719	104,787h	40 lbs. Fabric	.....	.....

City and State	Reinforced Concrete: Amount, Sq. Yds. or Miles	Reinforced Concrete: Cost	Reinforced Concrete: Reinforcement Wt. Per 100 Sq. Ft.	Not Reinforced: Amount, Sq. Yds. or Miles	Not Reinforced: Cost
Normal	1,247	5,304	.....	.....	.....
Oak Park	.....	.....	.....	45,488	175,354
Pana	7,014	28,163	.....	.....	.....
Rockford	.....	.....	.....	180,680	671,145
St. Charles	30,000	.....	40 lbs. Fabric	.....	.....
Sycamore	42,414	149,026a	40 lbs.	.....	.....
Waukegan	198,594	738,260a	.....	.....	.....
Wilmette	2,309	7,430	.....	29,290	73,916
Winnetka	24,940	115,000j	40 and 80 lbs. Fabric	.....	.....
Indiana:					
Anderson	.....	.....	.....	77,510	193,200
Bedford	.....	.....	.....	32,733	2,305
Columbus	.....	.....	.....	200	418
Elkhart	.....	.....	.....	49,196	162,150
Fort Wayne	400	1,206	.....	47,417	124,477k
Frankfort	14,984	43,838	.....	.....	.....
Indianapolis	34,407	92,986a	40 lbs. Bars	156,590A	156,900a
Kendallville	.....	.....	.....	58,847	131,176d
Lafayette	21,682	51,781c	28 lb. Fabric	4,145	7,725c
Michigan City	16,930	71,730s	43.8 lbs. Mesh	.....	.....
Muncie	15,524	36,266c	30 lbs. Fabric	1,824	4,797c
Peru	6,173	15,691a	50 lbs. Fabric	.....	.....
Richmond	.....	.....	51 lbs.	7,260	12,805
Rushville	5,000	12,500a	35 lbs. Mesh & Bars	.....	.....
Washington	290	2,805c	42 lbs. Fab	3,000	2.70sc
Winchester	.....	.....	.....	1,000	2,500
Iowa:					
Ames	71,340	154,659a	34 lbs. Bars	.....	.....
Chariton	16 blocks	51,000	Bars	.....	.....
Charles City	10,737	24,100a	30 lbs. Fabric	.....	.....
Clinton	9,500	27,500a	Bars	.....	.....
Council Bluffs	.....	.....	.....	43,280	2.15sc
Davenport	10,625	25,524c	40 lbs. Mesh	.....	.....
Grinnell	208	764	.....	62	146
Iowa City	41,000	129,000g	40 lbs. Bars	.....	.....
Keokuk	10,696	27,780a	42 lb. Fabric	.....	.....
Monona	20,000	60,000a	5 lbs. Bars s	.....	.....
Wilton	17,000	50,000f	5 lb. Bars s	.....	.....
Kansas:					
Atchison	.....	.....	.....	3,000	7,200
Dodge City	.....	.....	.....	1,500	.....
Herington	3 blks	2.80s	.....	.....	.....
Kansas City	.....	.....	.....	1/3 Mile	.....
Lawrence	3,122	1.90s	.....	32,350	1.76s
Ottawa	.....	.....	.....	798	2,052d
Parsons	.....	.....	.....	30,312	63,535a
Topeka	.....	.....	.....	32,698	74,369a
Wichita	9,200	30,100a	.....	84,100	259,450a
Kentucky:					
Ashland	74,162	385,882a	40 lbs. Bar & Mesh	.....	.....
Cynthiana	1,159	3,269	.....	.....	.....
Dayton	21,000	75,000	42 lbs.	.....	.....
Ludlow	14,549	50,006a	Fabric	.....	.....
Mt. Sterling	.....	.....	.....	16,000	.....
Olive Hill	.....	.....	.....	27,000	.....
Maine:					
Bangor	23,013	60,365d	½-inch Bars 66 lbs.	.....	.....
Waterville	½ mile	.....	8.68 sq. yd.	.....	.....
Massachusetts:					
Adams	4,120	11,712b	Bars	.....	.....
Boston	3,768	2.18sf	67 lbs. Bars	.....	.....
Brockton	6,000	20,000f	Bars	.....	.....
Fall River	.....	.....	.....	9,841	.....
Greenfield	2,174	3.08s	.....	.....	.....
Lawrence	6,210	2.80s	Bars 10 lbs. s	.....	.....
No. Adams	6,700	19,600b	57 lbs. Bars	.....	.....
Northampton	3,600	12,380f	Bars	185	855f
Pittsfield	15,855	2.60sc	70 to 100 lbs. Bars	.....	.....
Taunton	30,000	108,000	.....	.....	.....
Webster	0.71 mi.	34,880f	90 lbs. Bars	.....	.....
Michigan:					
Albion	1.642	6,515d	Bars	.....	.....
Ann Arbor	.....	.....	.....	5,000	12,309a
Bay City	.....	.....	.....	3,532	11,137c
Benton Harbor	.....	.....	.....	20,145	71,680d
Detroit	.....	.....	.....	5,136	17,636
Grand Haven	.....	.....	.....	46,409	87,805
Iron Mountain	4,203	2.24s	.....	11,876	2.51s
Highland Park	.....	.....	.....	7,502A	19,325a
Ironwood	.....	.....	.....	4,000	2.50s
Kalamazoo	.....	.....	.....	1,951	3,533
Muskegon Heights	.....	.....	.....	18,470	56,358h
Port Huron	36,421	124,519d	.....	.....	.....
Royal Oak	72,000	250,000a	78 lbs. Fabric	.....	.....
St. Joseph	.....	.....	.....	1,720	4,042j
Sault Ste Marie	.....	.....	.....	1,500	7,695d
Wyandotte	.....	.....	.....	88,000	293,500a
Ypsilanti	.....	.....	.....	18,000	45,000c
Minnesota:					
Brainerd	21,056	59,857	35 lbs. Bars	.....	.....
Duluth	5.72mi	573,252d	Bars	.....	.....
Fairmont	3,898	12,867a	60 lbs. Bars	.....	.....
International Falls	33,000	125,500a	45 lbs. Fabric	.....	.....
Minneapolis	.....	.....	.....	15,163	40,701f
Moorehead	32,785	113,483a	.....	.....	.....
New Ulm	33,050	74,200	35.7 lbs. Fabric	.....	.....
Rochester	.....	.....	90 lbs. Bars	6,000	13,200j
South St. Paul	15,910	39,601	.....	.....	.....
Virginia	5,693A	12,241	43 lbs. Bars	.....	.....
Winona	4,615	10,244	42 lbs. Fabric.	.....	.....
Mississippi:					
Vicksburg	.....	.....	.....	12,000	34,000
Missouri:					
Albany	4,000	12,000f	.....	.....	.....
Booneville	.....	.....	.....	10,000	25,000

City and State	Reinforced Concrete			Not Reinforced	
	Amount, Sq. Yds. or Miles	Cost	Reinforcement Wt. Per 100 Sq. Ft.	Amount, Sq. Yds. or Miles	Cost
Cameron	.....	.....	.....	.....	.....
Caruthersville	5,114	14,150	Bars	.....	.....
Columbia	.....	.....	.....	12,000	29,591
Fulton	7,651	23,694f	40 lbs. Fabric	.....	.....
Hamilton	.....	.....	.....	1,200	.....
Hannibal	15,500	35,000d	Bars	.....	.....
Henrietta	45,500	147,559	35.47 lbs. Fabric	.....	.....
Jefferson City	6,500	21,000a	Bars	.....	.....
Joplin	.....	.....	.....	3,131	7,413d
Kansas City	.....	.....	.....	96,198	192,496c
Keytesville	.....	.....	.....	244,202	589,559f
Kirksville	6,600	17,000d	Bars	.....	.....
Liberty	2,871	7,644d	40 lbs. Fabric	.....	.....
Maplewood	.....	.....	.....	2,000l	15,000
Mexico	24,067	75,380	48.8 lbs.	.....	.....
St. Joseph	11,000	37,000d	.....	.....	.....
St. Louis	.....	.....	28 to 100 lbs.	85,000	265,600f
Sedalia	.....	.....	36 lbs.	148,000	507,000d
Montana:	.....	.....	.....	34,600	69,040c
Butte	.....	.....	.....	.....	.....
Great Falls	12,677	42,383a	.....	.....	.....
Havre	2,382	6,866	40 lbs. Mesh	.....	.....
	32,648	122,606a	40 lbs. Bars	.....	.....
Nebraska:					
Fremont	.....	.....	.....	.....	.....
Hastings	26,866	53,550	.....	.....	.....
Holdrege	28,596	75,641d	28 lbs. Fabric	.....	.....
Kearney	12 miles l	.....	.....	.....	.....
Lincoln	.....	.....	30 lbs. Bars or Fabric	546	1,138b
New Jersey:	.....	.....	.....	4,975A	.....
Belleville	33,894	.....	39.4 lbs. Fabric	.....	.....
Camden	.....	.....	.....	2,086	4,900
Carteret	10,000	22,000	Fabrics	.....	.....
Millville	3,900	.....	.....	.....	.....
Newark	22,205	128,218a	.....	.....	.....
Newton	2,226	11,157a	78 lbs. Bars	.....	.....
Ocean City	.....	.....	.....	15,000	43,000
Phillipsburg	21,420	75,400	.....	.....	.....
Prospect Park	4,500	18,000c	90 lbs. Fabric	.....	.....
Rutherford	39,483	195,000f	58 lbs. Fabric	.....	.....
Trenton	5,567	14,073f	40 to 50 lbs. Bars	.....	.....
New York:					
Amsterdam	36,000	114,000f	.....	.....	.....
Corning	12,500	52,619c	59.3 lbs. Fabric	.....	.....
E. Aurora	2,080	8,050d	68 lbs. Mesh	.....	.....
Elmira	5,000	15,000	Fabric	.....	.....
Glens Falls	2,845	10,094c	70.6 lbs. Bars or Fabric	.....	.....
Gloversville	3,037	12,000f	65.3 lbs. Fabric	.....	.....
Herkimer	7,600	38,160f	.....	.....	.....
Hudson	.....	.....	.....	6,000	61,000
Jamestown	.....	.....	.....	1,545	4,452
Kenmore	17,300	51,900b	Fabric	.....	.....
Lancaster	25,057	141,631a	6.9 lbs. Bars S	.....	.....
Little Falls	2,300	13,250e	.....	.....	.....
Lockport	700	1,575a	43 lbs.	.....	.....
No. Tonawanda	19,379	65,639m	.....	.....	.....
Poughkeepsie	7,264	27,235	.....	.....	.....
Rochester	5,724	45,119a	40 lbs. Mesh & Bars	.....	.....
Rockville Center	½ mile	.....	.....	.....	.....
Seneca Falls	5,800	23,000a	56 lbs. Mesh & Bars	.....	.....
Syracuse	29,763	151,845a	42 lbs. Mesh	.....	.....
Utica	4,730	21,170a	57.8 lbs. Fabric	.....	.....
Watertown	3,400n	.....	60 lbs. Fabric	.....	.....
White Plains	28,988	105,831f	36 lbs.	.....	.....
North Carolina:					
Asheville	.....	.....	Bars	48,890	117,338j
Durham	.....	.....	.....	2,480	3,720j
Shelby	.....	.....	.....	10,000	20,000h
Wilson	.....	.....	.....	2,000	4,000
North Dakota:					
Dickinson	.....	.....	.....	18,002	64,193
Jamestown	45,000	182,000a	40-45 lbs. Bars	.....	.....
Ohio:					
Ada	1,900	8,500h	60 lbs. Bars	.....	.....
Akron	2,100	13,000	56 lbs. Fabric	.....	.....
Ashland	1,984	6,422	Bars	.....	.....
Bellefontaine	12,302	43,850	66 lbs. Bars	.....	.....
Cambridge	28,000	2.65sc	32 lbs. Fabric	.....	.....
Cleveland	14,000	62,480d	42 lbs. Fabric	.....	.....
Columbus	22,469	2.50sc	½-in. Bars	.....	.....
Dayton	65,587	182,889d	28 lbs. Fabric	.....	.....
Elyria	3,300	12,000a	56 lbs. Fabric	.....	.....
Lakewood	633	3,234	.....	.....	.....
Lorain	1,710A	5,265a	50 lbs. Fabric	.....	.....
Marion	19,810	26,692	59.4 lbs. Fabric	.....	.....
Napoleon	3,442	10,500	56 lbs. Mesh.	.....	.....
New Concord	.....	.....	.....	1,500	5,000
Oberlin	.....	.....	.....	6,300	5,000p
Salem	.....	.....	.....	1,152	1,900
Oklahoma:					
Durant	26,376	73,867d	24 lbs. Bars	.....	.....
Muskogee	.....	.....	.....	31,891	66,480
Oklahoma City	.....	.....	.....	57,000	230,000f
Ponca City	.....	.....	.....	9,000	36,000d
Tulsa	.....	.....	.....	88,034	335,407a
Oregon:					
Astoria	.....	.....	.....	24,068	73,015d
Eugene	.....	.....	.....	125,454	319,132a
Oregon City	.....	.....	.....	1,400	2,240
Portland	.....	.....	.....	262,865	664,786f
Salem	.....	.....	.....	109,596	221,114a
Pennsylvania:					
Allentown	1,877	.....	25 lbs. Fabric	.....	.....
Altoona	100,775	383,151d	65 lbs.	.....	.....
Clearfield	.....	.....	.....	10,000	35,000a
Coraopolis	2,360	8,616d	.....	.....	.....
Ebensburg	5,000	.....	.....	.....	.....
Frackville	13,629	74,276dg	.....	.....	.....

City and State	Reinforced Concrete — Amount, Sq. Yds. or Miles	Cost	Reinforcement Nt. Per 100 Sq. Ft.	Not Reinforced — Amount, Sq. Yds. or Miles	Cost
Jersey Shore	.....	.....	.....	5,454	1,636
Johnstown	12,884	48,365d	65 lbs. Fabric	.....	.....
Kane	.....	.....	.....	3.5 mi.	.....
Lehighton	6,500ft.	.....	.....	.....	.....
Lewistown	4,883	23,026d	56 lbs.	.....	.....
Munhall	8,936	34,520a	65 lbs. Fabric	.....	.....
New Brighton	1,386	4,278c	65 lbs. Fabric	.....	.....
New Castle	20,242	85,816h	65 lbs. Fabric	.....	.....
Norristown	6,645	27,600	.....	.....	.....
Northampton	210	840	.....	.....	.....
Oil City	3,348	17,000a	.....	.....	.....
Philadelphia	.....	.....	.....	67,551	212,025
Steelton	30,000r	.....	.....	.....	.....
Tyrone	27,000	95,000a	.....	.....	.....
Uniontown	11,005	34,869a	65 lbs. Fabric	.....	.....
Washington	48,000	177,000d	65 lbs. Fabric	.....	.....
Wilkinsburg	823 ft.	5,480d	.....	.....	.....
Williamsport	12,600	d	.....	.....	.....
York	562	1,630f	.....	2,775	9,490f
South Carolina:					
Greenville	.....	.....	.....	2,324	4,221
Orangeburg	.....	.....	.....	2,330	5,277
South Dakota:					
Mitchell	.....	.....	.....	538	1,065b
Tennessee:					
Jackson	.....	.....	.....	11,628	31,503
Texas:					
Wichita Falls	203,230	595,290w	.....	.....	.....
Utah:					
Ogden	.....	.....	.....	41,533	133,611
Provo	.....	.....	.....	14,000	31,500
Salt Lake City	.....	.....	.....	43,900	142,900
Vermont					
Barre	2,100	13,646	.....	.....	.....
Montpelier	20,000	935m	75 lbs. Bars	.....	.....
Rutland	2,958	7,514c	.....	.....	.....
Virginia:					
Lynchburg	.....	.....	.....	18,438	34,809
Richmond	.....	.....	.....	38,701	130,190f
Suffolk	.....	.....	.....	13,000	29,250
Washington:					
Aberdeen	.....	.....	.....	10,414	30,130a
Anacortes	.....	.....	.....	17,147	57,533a
Hoquiam	.....	.....	.....	26,096	96,877a
Seattle	11,000	28,000	.....	700,000	2,005,000
Wenatchee	.....	.....	.....	31,000	101,000a
Yakima	.....	.....	.....	26,512	70,798a
Yest Virginia:					
Clarksburg	20,440	94,000d	65 lbs. Fabric	.....	.....
Morgantown	31,000	2.35sb	6 lbs. s	.....	.....
Wisconsin:					
Appleton	25,263	81,635a	43 lbs. Fabric	.....	.....
Beloit	80,400	152,000j	30-40 lbs. Bars	.....	.....
Burlington	.....	.....	.....	9,945	22,972c
Chippewa Falls	10,937	27,960c	45 lbs. Bars & Mesh	.....	.....
Clintonville	11,919	33,373a	.....	.....	.....
Eau Claire	7,485	18,901	.....	.....	.....
Fond du Lac	.....	.....	.....	562	3,540a
Fort Atkinson	.....	.....	.....	1,883	4,143f
Janesville	13,112	36,710a	42-48.8 lbs.	.....	.....
Kenosha	44,592	128,011a	40 lbs. Fabric	.....	.....
Madison	52,251	230,228a	42-48 lbs.	.....	.....
Manitowoc	10,280	21,382	.....	.....	.....
Oshkosh	4,997	13,200f	.....	1,703	3,817f
Racine	106,000	275,000c	40 lbs.	.....	.....
Sheboygan	102,889	247,211a	.....	10,698A	22,126a
Superior	29,093	55,183d	29 lbs. Fabric	.....	.....
Tomahawk	39,000	110,000	.....	.....	.....
Waukesha	9,207	20,597d	40 lbs. Mesh.	23,676	47,539d
Wyoming:					
Cheyenne	.....	.....	.....	6,000	14,500
Canada:					
Guelph, Ont.	.....	.....	.....	13,562	26,256
Kitchener, Ont.	2,400	9,716	34 lbs.	.....	.....
Medicine Hat	.....	.....	.....	1,150	1,875
St. Jean, Que.	.....	.....	.....	25,684	56,504
St. Thomas, Ont.	.....	.....	.....	650	2.38s
Waterloo, Ont.	.....	.....	.....	2,273	4,930d

A—Alley paving; a—includes all items; b—pavement only included; c—pavement and grading included; d—paving, grading curb and gutters included; e—paving, base, grading, and curb and gutter included; f—includes wearing surface, base and grading; g—part of this included grading, part subgrade, and part 3-inch rock base; h—wearing surface, base, grading, curb and drainage included; i—base, grading and curb or 50 per cent.; j—base and wearing surface included; k—of this, 27,700 sq. yards, costing $57,634, is alley paving; l—laid in 1925 and 1926; m—excavation, base and drainage included; n—resurfacing; p—this is cost to city, State and Federal government paid remainder; q—includes 981 yards not reinforced; r—state aid; s—per square yard; v—varying in weight; w—base, curb and wearing surface included.

Street Resurfacing in Oswego*

Resurfacing with 4 inches of concrete on the old base is the standard procedure for worn-out pavements in Oswego, N. Y. The old top (which is usually bituminous) is removed, and the base carefully swept and cleaned. Just before placing the concrete, the base is thoroughly wetted, but no water is left standing. Concrete of 1:1½:3 mix is used, with 42 pounds of steel mesh reinforcement. Coarse aggregate is limited to a maximum size of 3 inches. Premolded expansion joints are generally placed about 40 feet apart, with longitudinal construction joints about 12 feet apart. At the end of each slab, an extra 6-foot strip of reinforcement is placed. The surface is struck off, belted with a wooden belt made of three 4-inch boards framed 2 inches apart, and broomed.

Some of this resurfaced pavement has been in use since 1919, and has given very good results, despite very heavy traffic. The concrete gives additional strength, besides providing a smooth surface.

*Abstracts from an article in Concrete Highway Magazine by J. Francis Dill, Comr. of Public Works, Oswego, N. Y.

Sheet Asphalt and Asphalt Concrete Pavements Laid in 1926

City and State	Sheet Asphalt Amount Sq. Yds. or Miles	Sheet Asphalt Cost	Asphalt Concrete Amount Sq. Yds. or Miles	Asphalt Concrete Cost
Alabama:				
Birmingham	48,689	$112,149	296,742	$680,723
Florence	45,000	110,000a	......	......
Montgomery	31,000	79,575b	......	......
Arizona:				
Tucson	......	......	9,915	19,392
Arkansas:				
Little Rock	......	......	9,063	......
Texarkana	......	......	30,000	90,000
California:				
Alameda	......	......	16,735	36,900d
Glendale	0.32 miles	38,807	4.24 miles	144,807e
Los Angeles	151,792	364,116f	487,660	788,433f
Monterey	......	......	3,000	189 to 205s
Ontario	......	......	77,778	120,000
Redwood City	......	......	89,009	162,310d
Sacramento	......	......	185,674	313,596g
San Bernardino	......	......	81,294	125,256f
San Diego	......	......	325,076	......
San Francisco	7,592	15,921f	402,451	1,053,959f
San Mateo	......	......	14,227	13,050
San Rafael	......	......	18,992	43,408
Santa Monica	23,884	38,692	1,333	2,160
Sausalito	......	......	4,444	8,000h
Vallejo	......	......	14,540	31,406
Colorado:				
Denver	......	......	432,754	1,125,000f
Greeley	......	......	52,000	77,277l
Connecticut:				
Hartford	80,640	265,126f	......	......
Meriden	25,115	68,000	......	......
New Haven	61,155	176,000j	......	......
Delaware:				
Wilmington	49,000	132,500	......	......
District of Columbia:				
Washington	17,154	134,286	......	......
Florida:				
Coral Gables	25,000	55,000	......	......
Lakeland	3,600	47,000	......	......
Ocala	300,000	......	......	......
Georgia:				
Atlanta	95,903	198,212j	......	......
Brunswick	10,000	17,000	......	......
Cartersville	22,000	85,000	......	......
Decatur	13,500	16,300	20,000	34,900
Idaho:				
Boise	......	......	26,236	43,675
Illinois:				
Chicago:	795,808j	......	236,413	......
Geneva	104,000	......	......	......
Joliet	32,000	122,700	......	......
Madison	53,350	219,000	......	......
Oak Park	28,963	272,597	......	......
Wheaton	36,700k	......	......	......
Indiana:				
Auburn	20,320	69,555	......	......
Elkhart	4,830	20,979	......	......
Fort Wayne	119,469	495,577l	39,931	163,670l
Hartford City	......	......	17,000k	......
Huntington	26,213	77,913	......	......
Indianapolis	109,631	333,196m	84,491	284,529m
Michigan City	50,706	226,238j	......	......
Muncie	14,630	42,417f	13,424	31,170
Peru	16,824	56,105l	......	......
Iowa:				
Charles City	5,000k	......	4,200k	16,612u
Council Bluffs	54,418a	2.29sd	......	......
Davenport	23,379	69,854a	......	......

City and State	Sheet Asphalt Amount Sq. Yds. or Miles	Sheet Asphalt Cost	Asphalt Concrete Amount Sq. Yds. or Miles	Asphalt Concrete Cost
North Carolina:				
Asheville	84,818	220,526d	......	......
Durham	84,265	248,581d	12,625	34,718
High Point	......	......	150,000	600,000l
Shelby	......	......	35,000	105,000l
Wilmington	69,101	2.49sd	......	......
North Dakota:				
Dickinson	......	......	26,715	108,020
Ohio:				
Akron	175,000	1,070,000	......	......
Alliance	36,984	162,600l	......	......
Ashtabula	24,180	140,833l	7,267	16,781l
Barnesville	4,703	......	......	......
Cleveland	51,086	304,616a	348,820	1,556,280a
Columbus	300,754	3.00sd	......	......
Dayton	59,901	163,638a	......	......
Fostoria	15,000	25,000g	......	......
Kenmore	......	......	12,070	38,857c
Lakewood	16,300	27,608k	56,737	353,391l
Lancaster	16,125	53,308a	......	......
Lorain	......	......	19,350	72,551l
Marion	11,165	53,267	......	......
Middletown	25,052	85,000f	......	......
Niles	......	......	11,390	30,522j
Salem	17,262	25,829	......	......
Wadsworth	7,100	44,263e	......	......
Oklahoma:				
Muskogee	200	500	......	......
Tulsa	......	......	94,941	452,917l
Oregon:				
Oregon City	......	......	62,000	60,760g
Portland	......	......	616,446	1,145,634tz
Salem	......	......	8,829	7,102r
Pennsylvania:				
Allentown	2,430	7,555f	8,827	24,538f
Clearfield	4,500	10,000j	......	......
Kingston	19,077	78,923a	......	......
Luzerne	300	1,200	......	......
Oil City	......	......	1,707	10,483j
Philadelphia	934,482	4,988,180f	......	......
Sharon	22,843x	80,982jy	......	......
Waynesburg	......	......	8,000	24,000
Williamsport	7,000k	......	......	......
York	29,734	101,689f	......	......
South Carolina:				
Charleston	119,534	329,782	......	......
Greenville	1,642	2,000	......	......
Texas:				
Houston	......	......	118,344	531,720
Vermont:				
Burlington	......	......	30,783	66,824j
Virginia:				
Danville	10,427	15,801g	30,677	29,982d
Lynchburg	......	......	14,272	12,116
Richmond	48,894	148,457f	......	......
Washington:				
Seattle	1,500	4,300	3,500	8,700
Yakima	......	......	10,239	24,395n
West Virginia:				
Princeton	......	......	15,000	45,000d
Wisconsin:				
Fond du Lac	28,231	102,309l	13,502k	36,237l
Kenosha	52,631	159,420l	18,140	51,067l
Madison	590	4,549n	......	......
Oshkosh	......	......	22,022	52,952td

Kansas:				
Parsons	135,689	269,025a	.....	.....
Topeka	.....	.....	188,855	722,243j
Wichita	.....	.....	46,200	160,670j
Kentucky:				
Paducah	44,054	105,018g	.....	.....
Paris	29,000p	.....	.....	.....
Maine:				
Portland	.....	.....	1,554	1,550
Maryland:				
Baltimore	553,835	.....	.....	.....
Massachusetts:				
Boston	7,491	3.26f	.....	.....
Brookline	3,103	6,993a	.....	.....
Haverhill	.....	.....	18,255	19,733f
Mansfield	.....	.....	18,000T	.....
Somerville	.....	.....	1.06 mi.	.....
Michigan:				
Ann Arbor	10,000	36,698ju	.....	.....
Benton Harbor	495k	899	.....	.....
Detroit	2,928,414	11,575,414	.....	.....
Highland Park	40,596	.....	.....	.....
Holland	43,850	143,660n	.....	.....
Ironwood	10,000	3,965	.....	.....
Kalamazoo	65,880	176,373	.....	.....
Ludington	38,530	94,000q	.....	.....
Pontiac	30,000	150,000i	.....	.....
Port Huron	16,561k	25,744	.....	.....
Royal Oak	20,511	92,000n	.....	.....
Sturgis	37,726	128,183	.....	.....
Minnesota:				
Anoka	.....	.....	40,000	112,000d
Minneapolis	.....	.....	152,544	349,844f
Rochester	1,000k	980	.....	.....
Mississippi:				
Corinth	76,500	260,933i	.....	.....
Missouri:				
Carthage	.....	.....	13,700	17,042g
Caruthersville	18,000	32,700	.....	.....
Hannibal	30,183	58,250	.....	.....
Joplin	.....	.....	19,850	37,715f
Kansas City	3,198	16,587f	17,930	54,656f
Moberly	.....	.....	3,000	8,000
St. Charles	1,912	6,608f	.....	.....
St. Joseph	.....	.....	10,000	28,300f
St. Louis	291,760	1,510,000a	60,165	268,861a
Nebraska:				
Grand Island	5,403	239sd	.....	.....
Lincoln	2,834	.....	114,613	.....
Omaha	32,564	83,400	334,956	766,746
Nevada:				
Reno	.....	.....	76,000	125,000
New Jersey:				
Belleville	4,100	.....	.....	.....
Camden	110,865	400,000f	59,085	130,000f
Elizabeth	7.55 miles	645,800a	.....	.....
Newark	358,603	2,168,889i	4,348	17,906i
New Brunswick	43,506	217,490a	.....	.....
North Plainfield	24,000	80,000d	.....	.....
Ocean City	90,000	360,000	.....	.....
Orange	14,448	2.29-3.49s	.....	.....
Rutherford	.....	.....	22,900	53,000f
Trenton	82,541	284,131f	.....	.....
West New York	.....	.....	900	5,100j
New York:				
Geneva	6,659	39,916l	.....	.....
Johnson City	.....	.....	2,869	12,419q
New York:				
Manhattan	143,803	1,240,849	.....	.....
Queens	414,377	2,090,373d	.....	.....
Richmond	.....	.....	108,457	515,433d
Niagara Falls	27,448	163,047a	10,774	62,732a
Poughkeepsie	42,082	155,518	.....	.....
Rochester	122,023v	919,592w	.....	.....
Syracuse	208,171	1,291,080j	41,043	145,926j
Canada:				
Halifax, N. S.	4,762	19,060d	.....	.....
Kitchener, Ont.	22,000	106,419l	.....	.....
Regina, Sask.	.....	.....	33,800	153,800a
Saint John, N. B.	5,269	13,607i	.....	.....
St. Thomas, Ont.	14,104	3.35sf	.....	.....
Sarnia, Ont.	17,567	50,240n	.....	.....
Valleyfield, Quebec	9,100t	8,282f	.....	.....
Waterloo, Ont.	4,738	14,687a	.....	.....

a—Includes wearing surface, base, curb, and grading; b—includes grading and drainage; c—includes wearing surface, base and gutters; d—includes base and wearing surface; e—includes surface, base, curbs, sidewalks, sewers, water pipe, and culverts and gutters where necessary; f—includes wearing surface, base, and grading; g—includes pavement only; h—includes wearing surface, base, grading, curb and culverts; i—includes all items and some sidewalks; j—includes all items; k—resurfacing or repair; l—includes wearing surface, base, grading, curb and drainage; m—includes wearing surface, base, grading, and drainage; n—includes inspection and overhead as well as surface, base, grading and curb and gutter; p—approximately; q—includes base, surface and inspection; r—paving and grading; s—per square yard; t—of this 19,388 sq. yds. was on macadam base; u—covers costs for both sheet asphalt and asphalt macadam repairs; v—of this, 42,338 sq. yds. were resurfacing; w—of this $332,632 were for resurfacing; x—of this, 8,360 sq. yds. resurfacing; y—of this, $21,689 were for resurfacing; z—of this, $237,744 were for 165,333 sq. yds. of asphaltic concrete resurfacing on old macadam base; aa—includes 13,640 sq. yds. of resurfacing on which the price was $1.53 per sq. yard.

Special Kinds of Pavements

City and State	Amount	Cost
Amiesite		
Atlanta, Ga.	3,830	10,140d
New Britain, Conn.	10,565	47,500d
Excelsior Springs, Mo.	2,200	6,000l
Elmira, N. Y.	1,800	8,000
Lockport, N. Y.	3,640	7,946d
Durham, N. C.	4,000	4,000l
Elyria, Ohio	7,100	17,700d
New Castle, Pa.	11,048	29,508c
Philadelphia, Pa.	200,403	674,910f
Fairmount, W. Va.	1,000	1,500
Moundsville, W. Va.	18,000	60,000
Asphalt Block		
St. Petersburg, Fla.	24.95 sq. yds.	2,063,550
Englewood, N. J.	2,230	8,075
Jamestown, N. Y.	3,480	9,758g
New York, N. Y.		
Manhattan	5,991	48,974
Queens	40,209	200,939
Vibrolithic		
Fort Smith, Ark.	1,660	$2,984
Little Rock, Ark.	6,000	
Redwood City, Calif.	18,328	44,041f
Santa Cruz, Calif.	13,326	
Vallejo, Calif.	15,900	32,190
Atlanta, Ga.	198,250	679,354d
Decatur, Ga.	9,750	23,380
Granite City, Ill.	60,000	66,000g
Harvey, Ill.	221,821	1,020,800c
Kewanee, Ill.	5,000	16,000
Lake Forest, Ill.	42,532	226,094d
Wheaton, Ill.	30,000	101,600d
Michigan City, Ind.	8,550	34,111d
Salina, Kansas	1,761	4,138
Ely, Minn.	8,382	35,912d
Virginia, Minn.	5,533	15,769
Nutley, N. J.	4,000	12,800g
Elyria, O.	9,000	43,000d
Tulsa, Okla.	31,382	153,486d
Marshfield, Ore.	25,050	59,568g
Altoona, Pa.	11,863	45,246a
Aberdeen, S. D.	28,187	77,265a
Yakima, Wash.	14,975	43,258d
Kaukauna, Wisc.	13,346	37,836d
Manitowoc, Wisc.	3,100	64,715
Stevens Point, Wisc.	26,000	82,160
Two Rivers, Wisc.	28,800	90,000

	Warrenite-Bituilithic	
Birmingham, Ala.	210,213	529,199
Little Rock, Ark.	57,089	....
Berkeley, Calif.	17,466	69,984
Los Angeles, Calif.	116,795	392,624f
Modesto, Calif.	30,804	61,600f
Red Bluff, Calif.	9,658	23,225
Redwood City, Calif.	13,512	....
Santa Monica, Calif.	167,394	301,310
Grand Junction, Colo.	95,363	330,000a
Pueblo, Colo.	9,697	....
Bridgeport, Conn.	215,876b	755,576f
Rome, Ga.	20,000	56,000
Rockford, Ill.	64,732	357,189d
Wheaton, Ill.	175,300	575,100d
Clinton, Ia.	12,000	33,660f
Council Bluffs, Ia.	15,000	2,575i
Grinnell, Ia.	21,642	8,889
Keokuk, Ia.	98,706	180,977d
Boston, Mass.	129,087	3.37s
Brookline, Mass.	20,531	70,685n
Lawrence, Mass.	13,474k	44,661
New Bedford, Mass.	12,838	55,702
Northbridge, Mass.	1.5 miles	30,000
Somerville, Mass.	1.07 miles	....
St. Cloud, Minn.	23,556	69,255i
Joplin, Mo.	72,780	162,495f
St. Louis, Mo.	227,485	1,028,985a
Bozeman, Mont.	7,320	24,370d
Great Falls, Mont.	22,426	76,255
Havelock, Nebr.	16,830	65,000d
Orange, N. J.	6,855	3.27sg
Elmira, N. Y.	8,000	35,000
Lockport, N. Y.	11,629	60,229d
Niagara Falls, N. Y.	5,523	34,083t
North Tonawanda, N. Y.	75,815m	276,544
Rochester, N. Y.	21,801	138,368d
Utica, N. Y.	135,200	740,000d
White Plains, N. Y.	27,798	107,797d
Yonkers, N. Y.	17,558	76,377g
Winston-Salem, N. C.	1,030	2,700a
Valley City, N. D.	5,727	28,504a
Newark, Ohio	35,862	126,726d
Oklahoma City, Okla.	90,000	466,672d
Allentown, Pa.	8,510	26,380f
Altoona, Pa.	20,777	80,155a
Johnstown, Pa.	17,757	88,969d
Steelton, Pa.	22,567	74,403
Dallas, Tex.	83,620	....
Ennis, Texas	58,000	202,000a
Houston, Texas	82,442	340,173d
Wichita Falls, Tex.	35,565	91,967
Salt Lake City, Utah	30,800	99,400
Aberdeen, Wash.	1,200	2,280d
Walla Walla, Wash.	32,664	55,214
North Bay, Ont	1.5 miles	74,851d
Petersborough, Ont.	10,850	22,917f

City and State	Cost	Amount
Regina, Sask.	4,500	14,500a
Willite		
Los Angeles, Calif.	122,298	248,130f
St. Louis, Mo.	15,200	83,120a
Rochester, N. Y.	53,938	350,355d
Dallas, Tex.	267,952	....
Wichita Falls, Tex.	248,041	782,575

In addition to the special kinds of pavements tabulated, there were a number of kinds, each reported by only one or two cities. These are given below:

Carolite—Altoona, Pa., 8,977 sq. yds., $34,008a.

Bessonite—Richmond, Va., 37,347 sq. yds., $64,905; Durham, N. C., 2,416 sq. yds., $2,416.

National—Los Angeles, Calif., 152,844e sq. yds., $415,-399f; Richmond,, Calif., 98,400 sq. yds., $210,000g.

Oil or Asphaltic Surfacing—Glendale, Calif., 1.05 miles, $8,901; Redwood City, Calif., 21,888 sq. yds., $15,759f.

Scoria—Dickinson, N. D., 17,700 sq. yds., $31,860.

Durite—Santa Monica, Calif., 52,250 sq. yds., $103,455.

Creosoted Wood Block—Minneapolis, Minn., 1,693 sq. yds. $6,259f; Boston, Mass., 729 sq. yds. $4,705.

Oil and Rock—Santa Monica, Calif., 4,320 sq. yds., $4,278.

Cinder—Nanty-Glo, Pa., 2 miles, $800; Barre, Vt., 900 sq. yds., $728; Morgantown, W. Va., 31,365 sq. yds., $5,227; Appleton, Wisc., 12,000 sq. yds.; Fort Atkinson, Wis., 300 sq. yds.; Elmira, N. Y., 4,000 sq. yds., $8,000.

Penetration and Surface Treating—Warren, O., 40,576 sq. yds., $27,203.

Sand Clay—Tallahasse, Fla., 123,200 sq. yds.

Sand Asphalt—Wilmington, N. C., 8,919 sq. yds., $1.65i per sq. yd.

Stone—Rensselaer, Ind., 7½ miles, $41,250; Zion, Ill., 1 mile, $7,000.

Asphalt and Sand Clay—Fredericksburg, Va., 23,500 sq. yds., $3,500.

Seal Coat—Ludington, Mich., 51,500 sq. yds., $12,500.

Shell—Houston, Tex., 1,300 sq. yds., $1,950.

Oil Cinder—Great Falls, Mont., 74,392 sq. yds., $4,510.

a—includes wearing surface, grading, base and curb and gutter; b—includes 91,505 sq. yds. or broken stone base; c—includes grading, curb, drainage and pavement; d—includes all items; e—on asphalt concrete base; f—includes wearing surface, base and grading; g—includes pavement or wearing surface only; h—includes 65,800 sq. yds. of resurfacing; i—includes base and pavement; j—double reflush; k—laid on stone base, surfacing cost was $2.05 per sq. yd.; l—laid on stone base; m—includes 27,570 sq. yds. resurfacing which cost $79,137; n—10,475 sq. yds. costing $29,215 are on macadam base, remainder on concrete base; s—per sq. yd.; t—base only.

Rock Asphalt and Bituminous Macadam Pavements Laid in 1926

	Rock Asphalt		Bituminous Macadam	
	Amount		Amount	
	Sq. Yds. or Miles	Cost	Sq. Yds. or Miles	Cost
Alabama:				
Anniston	6,000	6,300g	.....	.....
Sheffield	53,467	85,990	.....	.....
Arkansas:				
Marianna	10,000	12,000	.....	.....
Pine Bluffs	8,000	.....	.....	.....
Searcy	8 blks	.....	.....	.....
California:				
Alameda	.....	.....	39,680	39,281d
Berkeley	.....	.....	1,420	9,611
Glendale	.....	.....	1.65 miles	35,035
Napa	.....	.....	2,270	1,750
Newport Beach	.....	.....	89,000	112,140f
Oxnard	.....	.....	1 mile	.....
Monrovia	.....	.....	12,634	.....
Pasadena	.....	.....	182,877	136,566
Pittsburg	.....	.....	13,855	16,884
Richmond	.....	.....	21,500	29,000d
San Bernardino	.....	.....	21,673	28,140f
San Rafael	.....	.....	1,692	3,047
Upland	.....	.....	25,000	12,500
Connecticut:				
Bridgeport	.....	.....	13,287	24,586f
Middletown	2,800	5,600	.....	.....
New Haven	.....	.....	21,678	38,500j
New London	.....	.....	13,943	.....
Wallingford	.....	.....	10,700p	1.68sd
Florida:				
Coral Gables	.....	.....	750,000	750,000f
Key West	.....	.....	3 miles	160,000
Illinois:				
Chicago	.....	.....	105,858	.....
Winnetka	.....	.....	1,000	3,500d
Indiana:				
Hartford City	3,000	.....	.....	.....
Huntington	.....	.....	3,713	21,761
Princeton	.....	.....	6,400	15,550m
Rensselaer	13,200	21,000b	.....	.....
Kentucky:				
Ashland	15,425	74,238	.....	.....
Cynthiana	4,253	7,897	.....	.....
Hopkinsville	15,000	15,026	4 miles	12,000
Maine:				
Auburn	.....	.....	10,600	5,740e
Augusta	.....	.....	2,670	107,180j
Portland	.....	.....	46,111	10,253
So. Portland	.....	.....	6,000	.....
Maryland:				
Salisbury	.....	.....	12,000	7,200d
Massachusetts:				
Andover	.....	.....	19,778	.....
Boston	.....	.....	167,388	1,258f
Brockton	.....	.....	52,900	105,000f
Easthampton	.....	.....	2,590t	5,947
Fall River	.....	.....	55,118	.....
Grafton	.....	.....	2-3 mile	20,000
Greenfield	.....	.....	20,030	142,280
Haverhill	.....	.....	22,883	49,744f
Lawrence	.....	.....	45,419	2,30s
Mansfield	.....	.....	7,000t	.....
New Bedford	.....	.....	93,008	.....
Northampton	.....	.....	11,350	26,275f

Saugus	.....	.....	9,100	20,000
Somerville	.....	.....	1.32m	.....
Stoneham	.....	.....	6,000t	11,900
Webster	.....	.....	1.21 mi	29,760f
Michigan:				
Ironwood	.....	.....	4,000t	1.50s
Negaunee	.....	.....	20,000	26,000f
Wakefield	.....	.....	6,638T	18,800
Minnesota:				
Winona	17,796h	27,940	.....	.....
Mississippi:				
Vicksburg	7,000	20,000	.....	.....
Missouri:				
Columbia	4,784	10,293a	15,374	13,208a
Jefferson City	.....	.....	4,477	14,470l
Kansas City	7,995	33,209f	169,915	394,246f
St. Charles	26,179T	40,572f	5,473	14,948f
St. Louis	3,675	20,500l	.....	.....
New Hampshire:				
Berlin	.....	.....	5,000T	12,000
New Jersey:				
Belleville	.....	.....	9,190	.....
Englewood	.....	.....	24,450	29,340
Newton	.....	.....	5,300	4,800
North Plainfield	.....	.....	4,500T	8,500d
Nutley	.....	.....	20,353	30,597g
Orange	1,000	.....	5,579	1.87sg
Phillipsburg	.....	.....	4,855T	7,768
Plainfield	.....	.....	27,474	64,822l
Prospect Park	.....	.....	4,600	7,500l
Rutherford	.....	.....	33,000	.....
Somerville	.....	.....	6,000	6,000
New York:				
Amsterdam	.....	.....	.....	20,000f
East Syracuse	.....	.....	800	2,400
Elmira	3,500	4,000	10,000	12,000
Glen Falls	.....	.....	35,595	15,339g
Hudson	.....	.....	10,400	.....
Kenmore	4,000	.....	.....	.....
Norwich	.....	.....	1,555	840
Ogdensburg	.....	.....	5,400	4,644
Oneonta	.....	.....	20,000	12,000
Poughkeepsie	.....	.....	1,035	2,938
Rochester	.....	.....	1,454	5,719
Watertown	.....	.....	5,000T	6,232l
New York:				
Queens	.....	.....	1,232T	8,185f
Richmond	.....	.....	39,524	126,133f
North Carolina:				
Durham	3,000	3,000d	.....	.....
Ohio:				
Bellaire	.....	.....	3,180	13,000a
Bucyrus	.....	.....	1,200	.....
Gallipolis	.....	.....	3,000T	.....
Troy	4,000	.....	.....	.....
Warren	.....	.....	40,576	207,203
Oklahoma:				
Durant	.....	.....	6,742	25,189j
Pennsylvania:				
Lewiston	.....	.....	25,448r	5,493r
New Brighton	10,405	12,777	.....	.....
New Castle	5,860	13,514m	.....	.....
Norristown	3,200t	4,800	97,300	27,600
Northampton	.....	.....	3,882	.....
Philadelphia	.....	.....	39,757	88,901d
Towanda	.....	.....	29,045	32,681f
West Chester	.....	.....	30,000	20,000
Wilkinsburg	.....	.....	1.1 miles	44,651a
Rhode Island:				
Pawtucket	2,355	.....	78,272	.....
Woonsocket	2,000	.....	.....	.....
Tennessee:				
Clarksville	11,287	29,000a	.....	.....
Jackson	.....	.....	4,770	3,907
Texas:				
Dallas	82,430	.....	.....	.....
Houston	83,176	395,749a	41,457	24,064a
San Angelo	.....	.....	4,400	1.70sf

	Rock Asphalt		Bituminous Macadam	
	Amount Sq. Yds. or Miles	Cost	Amount Sq. Yds. or Miles	Cost
Vermont:				
Rutland	14,223k	18,040	4,556kb	3,449
Virginia:				
Newport News	7,573	9,466	38,508	34,657
Staunton	.....	.....	20,000	14,500l
Wisconsin:				
Ashland	.....	.....	7,165Ta b	9,171
Baraboo	.....	.....	11,000	.....
Eau Claire	.....	.....	1,470	2,752
Sparta	.....	.....	0.75 miles Ta	4,300
Canada:				
Fredericton, N. B.	.....	.....	4,600T	5,604
Kitchener, Ont.	.....	.....	2,000T	5,203q
Stratford, Ont.	.....	.....	3,600	5,712

T—tar macadam; b—Bituminous macadam; Ta—Tarvia; a—includes wearing surface, base, grading, and curb and gutter; c—on old macadam base; e—on crushed stone base; d—includes base and wearing surface; e—includes curb, sidewalks, sewers, water pipes, and culverts and gutters where necessary; f—includes wearing surface, base and grading; g—includes surface only; h—on old brick base; i—includes paving, grading and curb and gutter; j—includes all items; k—laid on existing grade; l—includes grading, and surface only; m—includes grading, base, wearing surface, drainage and incidentals; p—approximate; q—grading, underground services, curb and gutter included; r—17.44 sq. yards and $2,002 are for tar surfacing; s—per sq. yard; t—1,000 sq. yards tar macadam.

Stone Block and Brick Pavements Laid in 1926

	Stone Block		Brick	
	Amount	Cost	Amount	Cost
Alabama:				
Birmingham	.....	.....	70,396	305,140
Connecticut:				
Hartford	175	1,222	.....	.....
New Haven	3,170	21,000a	.....	.....
California:				
San Francisco	822t	1,163c	1,217	7,174c
Delaware:				
Wilmington	5,800	26,000	2,300	11,500
Florida:				
Lakeland	.....	.....	315,000	1,414,538e
St. Petersburg	.....	.....	38.8 miles	3,687,969
Georgia:				
Brunswick	.....	.....	5,000	.....
Idaho:				
Pocatello	1,006	.....	.....	.....
Illinois:				
Alton	.....	.....	16,355	69,505
Chicago	42,137m	.....	.....	.....
Normal	.....	.....	2,517	11,887
Rockford	.....	.....	35,179	191,408a
Waukegan	.....	.....	38,102	194,451a
Winnetka	.....	.....	910	5,630c
Indiana:				
Decatur	.....	.....	3,755	11,265
Fort Wayne	.....	.....	25,405d	234,292e
Iowa:				
Council Bluffs	.....	.....	500	3,505c
Iowa City	.....	.....	7,500	26,000e
Kansas:				
Augusta	.....	.....	5 miles	.....
Clay Center	.....	.....	1,700	3,562f
Dodge City	.....	.....	53,000	150,000c
Herington	.....	.....	14 blks.	3.05s
Lawrence	.....	.....	18,000k	1.80s
Neodesha	.....	.....	11,678	2.90-3.18s
Ottawa	.....	.....	27,776	103,779g
Topeka	.....	.....	4,300	16,503a
Wichita	.....	.....	700	2,200a

	Stone Block		Brick	
	Amount Sq. Yds. or Miles	Cost	Amount Sq. Yds. or Miles	Cost
Kentucky:				
Ashland	720	5,611a	.....	.....
Maine:				
Portland	25,995	144,584a	.....	.....
Maryland:				
Baltimore	9,113	.....	6,917	.....
Massachusetts:				
Boston	89,803u	2.97st	.....	.....
Michigan:				
Kalamazoo	.....	.....	354	13,038
Pontiac	.....	.....	1,800	.....
St. Joseph	.....	.....	12,773	44,963c
Minnesota:				
Minneapolis	767	4,603f	35,442	158,132f
Rochester	.....	.....	12,000	39,600c
St. Cloud	.....	.....	2,196	7,642c
Winona	.....	.....	17,233	3.17s
Mississippi:				
Lexington	.....	.....	14,000	50,000
Missouri:				
Joplin	.....	.....	2,150	5,160f
Kirkesville	.....	.....	4,574	7,644e
St. Joseph	.....	.....	18,000	81,700t
St. Louis	75,515	528,300g	20,900	131,000g
Nebraska:				
Fairbury	.....	.....	22,100	82,500a
Grand Island	.....	.....	929	3.305c
Hastings	.....	.....	1,490	5,084g
Lincoln	.....	.....	14,815	.....
Omaha	.....	.....	6,758	21,577
New Jersey:				
Belleville	1,900	.....	.....	.....
Elizabeth	.....	15,000g	.....	.....
Newark	844	11,612a	.....	.....
Trenton	11,182	68,370f	4,797	25,304f
New York:				
Elmira	.....	.....	4,000	18,000
Jamestown	.....	.....	79,253	354,973
Lockport	.....	.....	27,133	137,158a
New York:				
Manhattan	159,844	1,277,023	.....	.....
Queens	41,236	192,084	.....	.....
Richmond	18,836	134,924	.....	.....
Niagara Falls	.....	.....	26,406	186,604
No. Tonawanda	.....	.....	1,900	8,612g
Syracuse	736	h	10,801	h
Yonkers	1,016	6,833c	.....	.....
Utica	2,150	h	1,500	h
North Carolina:				
Durham	.....	.....	10,427	36,494c
Wilmington	.....	.....	3,742	3,625c
Winston Salem	1,132	4,300	.....	.....
Ohio:				
Akron	.....	.....	63,000	321,000
Alliance	.....	.....	1,563	11,000a
Cleveland	4,820	43,160g	233,620	1,290,940g
Columbus	4,109	4.75sc	18,919	3.40st to 3.70s
Dayton	.....	.....	19,621	182,889g
E. Cleveland	.....	.....	886	5,772
Elyria	.....	.....	5,200	32,000a
Jackson	.....	.....	35,861	110,250g
Lancaster	.....	.....	3,924	14,599a
Lima	.....	.....	557	2,831
London	.....	.....	20,000	70,000
Marion	.....	.....	11,848	58,669
Massillon	.....	.....	3,000	12,000
New Boston	.....	.....	11,800	40,500t
Niles	.....	.....	9,660	50,892a
Ravenna	.....	.....	10,000	46,000e
Toronto	.....	.....	3,888	19,868e
Warren	.....	.....	12,512	78,789a
Oklahoma:				
Oklahoma City	.....	.....	1,000	6,952g
Ponca City	.....	.....	56,000	280,000g
Pennsylvania:				
Altoona	.....	.....	1,365	6,825

	Waterbound Macadam		Gravel	
	Amount Sq. Yds. or Miles	Cost	Amount Sq. Yds. or Miles	Cost
Kentucky:				
Paducah	.....	.....	30,700 ft.	9,500a
Winchester	10,000	.....	.....	.....
Maine:				
Augusta	.....	.....	0.56 mi.	10,000g
Bangor	.....	.....	1,000	.....
Portland	.....	.....	11,963T	26,916
Waterville	.....	.....	5 miles	.....
Massachusetts:				
Andover	.....	.....	1 mile pc	.....
Brockton	.....	.....	75,000	110,000d
Greenfield	.....	.....	25 mi.	.....
Mansfield	.....	.....	15,000	.....
Northbridge	2 miles	11,000	2 miles	5,000
Orange	.....	.....	2/3 mile	.....
Peabody	4,000	4,000d	10,000	6,000d
Saugus	.....	.....	27,000T	14,000
Stoneham	.....	.....	5,000	.....
Michigan:				
Hastings	.....	.....	7,853	2,783
Negaunee	.....	.....	2 miles	6,000d
Minnesota:				
Cloquet	.....	.....	35,600	5,849
Duluth	.....	.....	5 miles	14,618
Hutchinson	.....	.....	10 blks	.....
Montevideo	.....	.....	20,000j	2,400j
Port Huron	.....	.....	5,707	5,711
Rochester	.....	.....	6,000f	4,760
Missouri:				
Columbia	.....	.....	4,489	5,049d
Fulton	3,600	2,000	.....	.....
Joplin	.....	.....	31,398	26,394
Keytesville	.....	.....	2,000	1,600
Poplar Bluff	.....	.....	4,000	.....
Montana:				
Miles City	.....	.....	5,000	235
Nebraska:				
Hastings	.....	.....	32,625	28,938j
New Hampshire:				
Berlin	.....	.....	20,000	35,000
New Jersey:				
Freehold	.....	.....	10,000	2,000
Lambertville	8,000	.....	.....	.....
Millville	.....	.....	13,000	.....
Salem	.....	.....	3,500T	1,200
Seaside Heights	.....	.....	54,630	30,085g
Vineland	.....	.....	1 mile	.....
New York:				
Elmira	4,000	4,200	.....	.....
Gloversville	.....	.....	6,310	4,362
Watertown	1,600	1,400d	.....	.....
Ohio:				
Delaware	4,700	0.85sk	.....	.....
Gallipolis	2,000	.....	.....	.....
Lancaster	895	1,429	.....	.....
Troy	.....	.....	10,000l	.....
Oklahoma:				
Muskogee	.....	.....	2,700	1,000
Oklahoma City	.....	.....	1,790	5,656
Oregon:				
Ashland	4,000	2,000	.....	.....
Astoria	3,377	4,922	.....	.....
Eugene	4,202	2,324	.....	.....
La Grande	33,800	26,500d	.....	.....
Portland	6,955	12,773T	.....	.....
Pennsylvania:				
Hanover	3,200	2,460	.....	.....
Jersey Shore	16,809	7,270	.....	.....
Lewistown	1,082	486	.....	.....
Rhode Island:				
Pawtucket	.....	.....	5.4 miles	.....
Texas:				
Brownwood	.....	.....	166,667T	67,500
Houston	.....	.....	118,623	110,732m
Weatherford	.....	.....	30 miles	.....
Utah:				
Tooele	.....	.....	70,404	1,704g

Carbondale	.....	.....	19,886	124,871e
Coraopolis	.....	.....	21,275	105,102f
Ebensburg	.....	.....	4,000	5,200a
Johnstown	.....	.....	29,617	167,312g
Monessen	.....	.....	14,411	57,803k
Munhall	.....	.....	13,926	.....
New Castle	.....	.....	12,154	71,253e
Philadelphia	368,610	1,700,916f	.....	.....
Rankin	.....	.....	8,575	30,125c
Sharon	.....	.....	7,702	31,632a
Sharpsville	.....	.....	18,000	70,000
Warren	.....	.....	4,214	25,098
Washington	.....	.....	11,800	48,000f
Waynesburg	.....	.....	1,500	5,550
Wilkinsburg	.....	.....	4,879ft	68,750g
Williamsport	.....	.....	20,000	.....
York	.....	.....	342	1,845
Rhode Island:				
Pawtucket	7,207	.....	.....	.....
Texas:				
Childress	.....	.....	50 blks	223,000
Dallas	.....	.....	33,594	.....
Houston	.....	.....	2,728	15,565a
San Angelo	.....	.....	41,000	3.30sf
Tyler	.....	.....	94,000	278,240f
Virginia:				
Lynchburg	.....	.....	5,000	12,000
Richmond	.....	.....	8,390	39,872f
Washington:				
Seattle	.....	.....	500	2,000
West Virginia:				
Fairmont	.....	.....	4,150l	15,355l
Morgantown	.....	.....	10,672	2.10sj
Wisconsin:				
Chippewa Falls	.....	.....	6,189	27,000a
Janesville	.....	.....	2,766b	.....
Canada:				
St. John, N. B.	1,000	.....	.....	.....

a—includes all items; b—relaid; c—base and wearing surface included; d—laid on street car tracks; e—includes wearing surface, base, grading, curb, and drainage; f—includes wearing surface, base, and grading; g—includes wearing surface, base, grading, and curb and gutter; h—included in other costs; i—950 sq. yds. on slag base cost $2,755; j—wearing surface only; k—resurfacing or repairing; m—6,023 sq. yds. are sandstone; s—per square yard; t—Basalt; v—recut.

Waterbound Macadam and Gravel Laid in 1926

	Waterbound Macadam		Gravel	
	Amount Sq. Yds. or Miles	Cost	Amount Sq. Yds. or Miles	Cost
Alabama				
Florence	.....	.....	15,000c	20,000a
Arkansas:				
Fayetteville	.....	.....	17,000	10,000
Marianna	.....	.....	30 miles b	330,000
Pine Bluff	.....	.....	11,000	.....
California:				
Orange	.....	.....	55,000	.....
Orland	.....	.....	1,500	1,500
Red Bluff	9,658	.....	.....	.....
Sausalito	7,777	8,400a	.....	.....
Colorado:				
Colorado Springs	.....	.....	80,000	6,645e
Denver	936,603	1,023,000d	.....	.....
Greeley	.....	.....	60,000	6,426
La Junta	.....	.....	45,000	.....
Connecticut:				
Hartford	52,300	69,700	.....	.....
Idaho:				
Burley	.....	.....	11,440	1,600g
Illinois:				
Rockford	2,723	7,530a	.....	.....
Indiana:				
Elwood	.....	.....	1,500f	2,475
Muncie	685	1,666h	585	856h
Vermont:				
Barre	.....	.....	2,020	3,964
Newport	.....	.....	3,080	2,000p
Rutland	.....	.....	3.5 miles	9,000p
Virginia:				
Fredericksburg	.....	.....	28,700	3,850g
Richmond	.....	.....	75,258	.....
Washington:				
Aberdeen	.....	.....	2.66 miles	38,575
Hoquiam	.....	.....	½ miles	.....
Yakima	.....	.....	3,680	3,921
West Virginia:				
Fairmont	4,500	4,500	.....	.....
Wisconsin:				
Appleton	.....	.....	11,350	.....
Clintonville	.....	.....	4,502	6,750a
Fond du Lac	.....	.....	10 miles p	.....
Fort Atkinson	1,200	1,200	3,454	600
Lake Geneva	.....	.....	2,000	600
Manitowoc	10,000	7,500	6,000	4,200
Oshkosh	5,456	8,898	.....	.....
Rhinelander	.....	.....	2,500 ft	.....
Watertown	.....	.....	3,000	.....
Wyoming:				
Sheridan	.....	.....	9,600	2,980d
Canada:				
Fredericton, N. B.	.....	.....	8 miles	.....
Halifax, N. S.	1,000	1,500	.....	.....
Medicine Hat, Alb.	.....	.....	5 miles	6,000
North Bay, Ont.	2 miles	3,500	10 miles	.....
Pembroke, Ont.	.....	.....	11,000	3,042
Valleyfield, Que	2 miles	13,515d	.....	.....

T—with tar, tarvia, or oil; c—cinder; a—includes all items; b—state highway; c—chert; d—wearing surface, base and grading; e—labor cost; f—cubic yards; g—grading and surfacing; h—job complete including grading; i—includes 8,000 sq. yds. tarvia treated gravel, cost $900; j—paving, curb and gutter, and grading included; k—stone only; l—repairs; m—includes surface, base and engineering; p—approximately s—per square yard.

Cement Sidewalks

City and State	Amount sq. ft. or miles	Cost
Alabama:		
Anniston	16,000s	22,000
Birmingham	64,203s	99,018
Dothan	20,000s	35,000
Florence	5,000s	7,000
Montgomery	41,633	6,750
Opelika	6,170s	9,545
Sheffield	100,000	16,500
Arkansas:		
Pine Bluff	8,000	.....
California:		
Alameda	171,000	2,736
Berkeley	8,487	1,877
Glendale	7.34 mi.	36,409
Los Angeles	5,651,087	972,808
Monrovia	5,673	.....
Monterey	40,000	16,206
Newport Beach	44,400s	71,000
Orange	5,000	750
Orland	1,800	270 16b
Oxnard	52,700	5,780
Pasadena	311,376	2,210
Pittsburg	3,800	15,278
Redwood City	98,335	58,000
Richmond	35,000	69,101
Sacramento	339,379	59,162
San Francisco	32,769s	4,278
Santa Monica	38,890	.....
Colorado:		
Denver	57,222s	80,000
Greeley	2,000s	3,000
La Junta	5,000	800
Pueblo	15,000	16b
Connecticut:		
Putnam	500	250
Florida:		
Coral Gables	2,406,000	481,200
Lake City	500s	.....
St. Petersburg	484,771c	82,411
Tallahassee	50,000	10,000
Georgia:		
Americus	2,000s	3,000
Atlanta	99,973s	165,875
Rome	16,000s	28,000
Idaho:		
Boise	2,869s	2,725

City and State	Amount sq. ft. or miles	Cost
Burley	20,000	3,600
Lewiston	9,000	940
Illinois:		
Alton	46,400	11,600
Chester	600	16b
Chicago	2,497,000	....
Edwardsville	7,250	1,500
Kewanee	3,300	6,900
Lake Forest	25,655	7,312
Normal	16,000	3,400
Oak Park	5.33 mi.	48,224
Waukegan	604,875	150,792
Wilmette	42,268	12,438
Winnetka	21,700	6,100
Zion	6,000	7,500
Indiana:		
Anderson	56,653	11,783
Decatur	187,500	9,685
Elkhart	13,215s	25,756
Elwood	16,500	3,300
Fort Wayne	10.3 mi.	54,950
Indianapolis	449,327	120,658
Lafayette	4,829s	9,867
Michigan City	1,638l	1,546
Muncie	27,933l	26,638
Noblesville	10,070	1,611
Peru	3,115	....
Princeton	12,000	2,160
Richmond	56,495	8,079
Sullivan	5,000	18b
Washington	1,800	154
Winchester	350s	700
Iowa:		
Ames	42,831	6,597
Grinnell	301	45
Kansas:		
Dodge City	10 blks	....
Lawrence	24,000	18b
Parsons	2,056s	3,238
Topeka	55,000	9,900
Kentucky:		
Winchester	2,000	25b
Louisiana:		
Minden	12,960l	10,368
Thibodeaux	5 miles	....
Maine:		
Augusta	408s	1,224
Bangor	1,349s	3,228
Jay	....	2,500
Maryland:		
Baltimore	106,075	198,321
Salisbury	2,000s	3,600
Takoma Pk.	2,377	5,704
Massachusetts:		
Adams	2,259s	5,422
Boston	65,406	.23b
Brockton	900s	1,800
Easthampton	686s	1,880
Greenfield	8,500	2,012
Haverhill	5,772s	14,430
Lawrence	5,445s	2.15s
Mansfield	950	....
New Bedford	62,219s	....
Newton	140,794	49,645g
Northampton	3,615s	6,000
Northbridge	2,000l	3,500
Orange	⅛ mile	....
Pittsfield	5,035s	2.95s
Somerville	1.86 mi.	....
Webster	350l	....
Michigan:		
Bay City	3,857s	6,368
Detroit	11,424,732	....
Hastings	19,600	1,833
Holland	37,500	4,688
Iron Mountain	10,510	15⅓b
Munising	4,000	....
Negaunee	2,000s	3,000
Niles	3,000s	....
Owasso	7,150s	12,550
Pontiac	79,172	16,281
Port Huron	3,000	5,493
Royal Oak	172,000	30,500
St. Joseph	8,000	1,500
Sault Ste. Marie	327	....
Minnesota:		
Anoka	1,000s	1,000
Cloquet	23,702	2,844
Duluth	18.2 mi.	94,891
Hutchinson	6 blks.	18b
New Ulm	800s	824
Rochester	6,000s	1,30s
St. Cloud	6,100s	5,307
Virginia	18,598	3,440
Winona	5 miles	12b
Mississippi:		
Vicksburg	4 miles	20,000
Missouri:		
Carthage	4,000	2,000
Columbia	8,054	2,224
Fulton	1,000l	....
Kansas City	400,000	75,000
St. Charles	7,500	1,800
Montana:		
Great Falls	4,384	1,007

City and State	Amount sq. ft. or miles	Cost
Nebraska:		
Grand Island	29,339	4,049
Kearney	13,700s	....
Lincoln	31,000	....
Nevada:		
Reno	7.000	....
New Hampshire:		
Berlin	4,000s	10,000
New Jersey:		
Englewood	24,000	25,400
Freehold	8,000	1,440
Newton	6,200	2,170
Nutley	4,815s	9,769
Orange	21,900	25b
Plainfield	36,125	7,586
Rutherford	2.75 mi.	15,000
Seaside Heights	33,742	6,780
Somerville	20,000	8,000
Trenton	530s	1,389
Vineland	20,000	4,400
New York:		
Corning	22,230	4,446
East Aurora	9,000	1,800
East Syracuse	400	80
Elmira	40,000	8,000
Glens Falls	45,721	8,927
Gloversville	15,555	3,485
Herkimer	12,000	2,400
Jamestown	10,700s	20,560
Kenmore	8,300s	15,318
Niagara Falls	126,560	28,792
Ogdensburg	27,240	7,300
Oneonta	11,000s	23,000
Poughkeepsie	63,060	17,031
Seneca Falls	10,000	2,500
Syracuse	10 miles	50,000
Tarrytown	8,000	48b
Utica	9 miles	61,500
Watertown	2½ miles	....
White Plains	42,895	20,509
North Carolina:		
Durham	1,750s	3,062
High Point	25,000s	50,000
Mooresville	1,000s	1,600
Thomasville	3,750s	6,400
Winston-Salem	25,050	40,000
North Dakota:		
Dickinson	400s	720
Jamestown	1,400s	3,290
Valley City	1,200s	1.26s
Williston	1,550s	....
Ohio:		
Akron	15,700s	31,500
Bellefontaine	....	505
Bucyrus	4,000	1,000
Cuyahoga Falls	18,000	25b
Dayton	24,601	8,161
Elyria	2,200ds	4,100
Gallipolis	1,000s	....
Jackson	6,000	....
Kenmore	40,000	....
Lancaster	50,000	15b
Lorain	12,000	....
Marion	55,087	6,654
Massillon	58,000	....
Newark	833s	1,125
Salem	50,000	1,500
Troy	10,000	....
Warren	77,000	20,000
Oklahoma:		
Altus	12,000	2,200
Muskogee	1,300	1,700
Ponca City	5,000	1,000
Oregon:		
Albany	840	....
Ashland	3.5 mi.l	35,000
Astoria	8,160s	14,397
Eugene	18,000	18,000
La Grande	4,500s	8,100
Marshfield	95,167	16,179
Oregon City	19,000	2,800
Portland	92,487lf	292,277
Salem	320,000	....
Pennsylvania:		
Berwick	1 mile	16b
Clearfield	1,000s	12,000
East Stroudsburg	25,000	5,000
Freeland	510s	2,200
Hanover	4,500s	6,480
Jersey Shore	19,394	3,878
Kane	1,003l	....
Lansford	1,500l	50cb
Nanty-Glo	¼ mile	30b
Northampton	46,495	....
Palmerton	2,800s	8,400
Punxsutawney	5,000	1,500
Sharon	49,230	12,307
Wilkinsburg	2 miles	....
Williamsport	40,000	....
Rhode Island:		
Pawtucket	12,900s	2.48s
South Carolina:		
Greenville	707s	919
Orangeburg	351	512

City and State	Amount sq. ft. or miles	Cost
South Dakota:		
Aberdeen	21,600	4,752
Huron	1,000s	1,530
Mitchell	16,425	2,628
Tennessee:		
Alcoa	18,960	4,560
Jackson	55,000	....
Texas:		
Alice	2 mi.	...
Brownwood	18,000	2,880
San Angelo	3,500s	1,80s
Tyler	110,300	22,060
Wichita Falls	22,000s	39,600
Utah:		
Ogden	69,425	13,810
Salt Lake City	145,800	36,000
Vermont:		
Barre	1,469s	6,155
Bellows Falls	1,000s	...
Newport	...	8,367e
Virginia:		
Lynchburg	13,000s	24,213
Richmond	2,465s	5,316
Staunton	½ mi.	...
Washington:		
Aberdeen	6,111s	17,000
Anacortes	15,000	3,750
Dayton	5,000	1,000
Hoquiam	½ mile	....
Seattle	200,000s	530,000
West Virginia:		
Clarksburg	5,000s	12,000
Princeton	1,400s	3,200
Wisconsin:		
Antigo	2,000s	1.08s
Appleton	125,672	25,134
Chippewa Falls	650s	760
Eau Claire	6,163s	7,446
Fort Atkinson	3,076	369
Green Bay	50,000	10,000
Janesille	1 mileh	....
Kaukauna	26,000	5,200
Lake Geneva	4,000	880
Norwalk	4 miles	....
Racine	90,000	....
Superior	36,998	4,800
Wyoming:		
Cheyenne	20,000	5,000
Sheridan	15,700	3,100
Canada:		
Fredericton, N. B.	3,270s	4,390
Guelph, Ont.	862s	1,393
Hawkesbury, Ont.	9,800	3,900
Kitchener, Ont.	3.5 miles	22,527
North Bay, Ont.	35 miles	....
Oshawa, Ont.	26,540	5,980
Regina, Sask.	85,000	21,400
St. Jean, Que.	2,050s	4,920
St. John, N. B.	1,000p	....
St. Thomas, Ont.	2,544	25c
Sarnia, Ont.	2,275s	3,895
Stratford, Ont.	4,050	870
Valleyfield, Que.	1,026s	2,403

a—5 feet wide; b—per square foot; c—cement block; d—2,000 yards of this are stone; e—includes curb and gutter; f—includes grading; g—sidewalks and drives; h—built privately; l—lineal feet; p—approximately; s—square yard.

Concrete Pavement Contracted During 1926*

	Sq. yds. of concrete street paving contracted during 1926	Sq. yds. of concrete alley paving contracted during 1926
Alabama	944,254	74,949
Arizona	18,876	6,450
Arkansas	631,731	1,970
California	6,979,005	172,040
Colorado	64,062	212,156
Connecticut	98,516	....
Delaware	3,442	....
District of Columbia	194,566	40,000
Florida	1,524,474	307,100
Georgia	823,724	44,304
Idaho	40,187	....
Illinois	6,793,792	1,618,882
Indiana	1,241,903	180,799
Iowa	1,221,973	91,633
Kansas	479,057	60,291
Kentucky	392,406	120,350
Louisiana	380,656	62,966
Maine	53,149	....
Maryland	377,162	82,668
Massachusetts	338,895	526
Michigan	2,060,762	558,213
Minnesota	477,081	76,651
Mississippi	406,233	113,992
Missouri	1,257,808	151,655
Montana	45,516	2,343
Nebraska	365,857	49,756
Nevada	24,984	1,111
New Hampshire	27,851	142
New Jersey	1,712,059	9,400
New Mexico	57,684	....
New York	3,079,519	10,486
North Carolina	1,149,687	51,863
North Dakota	89,457	8,109
Ohio	1,403,086	107,849
Oklahoma	1,032,669	31,572
Oregon	681,077	8,606
Pennsylvania	1,789,450	99,267
South Carolina	30,641	31,640
South Dakota	51,678	1,260
Tennessee	585,803	53,969
Texas	856,622	79,114
Utah	141,033	11,858
Vermont	56,031	....
Virginia	386,411	19,628
Washington	1,564,442	32,553
West Virginia	336,464	26,774
Wisconsin	1,677,995	329,699
Wyoming	18,605	7,740
Totals	43,968,335	4,952,334

*Data furnished by Portland Cement Association.

Joint Fillers and Expansion Joints

One if the inquiries in our paving questionnaire related to joint fillers for brick and stone block pavements and between pavement and curb; also in regard to width of curb joints and material used for expansion joints in concrete pavements. About five hundred city engineers answered these questions. A summary of answers is given below.

A great variety of practice was shown by the answers to pavement and joint fillers. Asphalt, used alone or with sand or gravel, was the most popular filler, 102 cities using it with brick pavements, 8 with stone, and 55 between pavement and curb. Asphaltic cement was used by 56 for brick, by 14 for stone block, and by 16 for pavement and curb filler. Cement grout was reported as used by 57 cities for brick filler, by 42 for stone block, and by 4 for pavement and curb filler. Mastic was used by 12 for brick, by 5 for stone block, and by 15 between curb and pavement. Forty five cities used some prepared material for joints between curb and pavement; 47 specified "Elastite," a few others reported using a mixture of asphalt and cement, pitch, wood, sand or Tarvia. Twelve cities reported using no filler between curb and pavement.

Considerable variety of opinion appears to exist in regard to width of curb joints, and answers ranging from ⅛ to 2 inches were received, but the answers indicated that the great weight of practice lies between ¼ and ½ inch. Of the cities answering, thirty-five reported ⅛-inch joints, sixty five ¼-inch, thirty nine ⅜-inch, and one hundred and nine ½-inch. In addition, eight reported 3/16-inch, four ⅝-inch, twenty ¾-inch,

one 7/8-inch, twelve 1-inch, two 1/16-inch, one 1½-inch, and one 2-inch.

In reply to the question regarding expansion joints in concrete pavements 272 cities reported using a prepared filler, and 115 reported other materials. There was a variety of answers to this question, indicating that many of the cities not so reporting did use prepared fillers. Next to the manufactured joint materials, asphalt and bituminous joint filler were most popular, being reported by 57 cities. Three cities reported the use of tar paper, one a mixture of asphalt and sawdust, and two creosoted wood. Five reported no expansion joints used.

Filler for Granite Block Pavements

Bituminous Joint Filler Used in Manhattan. Mechanical Mixing Used. General Specifications of Materials. Methods of Filling Joints.

Since 1880, when the bituminous joint filler was introduced, many experiments and a great deal of research have been undertaken to produce a joint filler which would not be materially affected by climatic conditions, which is stable, waterproof, noiseless and will wear level with the granite. In the Borough of Manhattan this question has resolved itself into the use of an asphalt filler having a penetration between 60 and 70 and a melting point between 150°F-130°F. The melting point is controlled in order that the filler may be heated on the street without elaborate heating apparatus, and the penetration is controlled so as to insure that it will flow readily into the joints.

The joint filler used is a mixture of asphalt paving cement and hot, dry sand in the proportions of 4 parts of sand to 6 parts of paving cement by volume. The use of this admixture was adopted after careful study, and it is the opinion of the writer that the addition of the sand increases the stability of the filler very materially, works great economy and adds to the filler a certain wearing quality which is most desirable. We find since the introduction of this sand into the asphalt cement that the filler does not run out of the joints on grades or into the gutters where it is necessary to make a slightly higher crown than usual. The object of this joint filler is to keep the blocks upright, to preserve their arris, to reduce the noise which naturally comes from a hard pavement and to waterproof the same.

We find in Manhattan, where the streets are continuously being opened to repair and install subsurface structures, that the asphalt joint filler adapts itself to this situation admirably in that the granite block filled with this asphalt joint filler can be easily opened without destroying the granite, and can be restored and opened to traffic immediately.

In a city like New York, where the loads are exceedingly heavy and the speed of the vehicles is fast and where the surface of the streets are occupied to such a great extent by manhole heads, a great deal of vibration is set up. If the joint filler in a granite block pavement is such as to transmit this vibration to the curbs and, in turn, through the sidewalks to the adjoining buildings, a great deal of injury is done to the value of the building on account of vibration and it has been found that where asphalt filler has been used in the joints of granite block pavement, the vibration transmitted to the abutting buildings is negligible.

Inasmuch as the filler specified in Manhattan is obtained by the distillation of an asphaltic petroleum, it is essential that the methods of the refining be carefully examined into. The method of preparing the filler for application and the method of application should be carefully controlled.

We find that the best result will be obtained if the asphalt is maintained in the kettles on the street at a temperature between 325° F. and 400° F, which is determined by equipping the kettles with thermometers. The sand, all of which must pass a 10-mesh sieve and not less than 85% pass a 20-mesh sieve, is heated to a temperature between 300° F. and 400° F., the filler being poured into the joints between these limits.

When we began to use the admixture of sand and asphalt, it was the practice to mix the hot asphalt and sand in cans having a long spout and pour directly from these. Owing to the difference in specific gravity of the asphalt and sand, and the consequent rapid subsidence of the latter, this method was discontinued, and in 1917 the asphalt and sand were mixed in wheelbarrows, and the resultant asphalt grout flushed on to the surface of the pavement and broomed into the joints.

A few years ago the method of mixing was improved by the acquisition of mechanical mixers of the pug-mill type. The asphalt and sand are placed in the mixer in the proper proportions and the asphalt grout is then emptied from the mixer into wheelbarrows, dumped on the surface of the pavement and broomed into the joints. Thousands of granite blocks removed for the purpose of inspection show that invariably the asphalt joint filler has filled the joint from bottom to top.

It is the opinion of the writer that a well cut, closely laid granite block pavement, filled with asphalt joint filler, laid on streets where heavy high-speed traffic, whether horsedrawn, motor driven, steel-tired or rubber-tired, is eminently satisfactory, as the same is essentially noiseless, skid-proof, easily and satisfactorily repaired, and yet sufficiently smooth to compare favorably with other types of pavements, and is unquestionably the most durable type which has come to the writer's attention.

*Abstract of a paper before the Fifth Annual Asphalt Paving Conference by C. M. Pinckney, chief engineer of public works, Borough of Manhattan, New York.

Recent Legal Decisions

CITY MAY IMPROVE STREETS BY DISTRICTS AND PROVIDE AN ALTERNATIVE FOR DIFFERENT MATERIALS

The Kentucky Court of Appeals holds, Dowdy v. City of Mayfield, 281 S. W. 485, that a city, by ordinance, may provide in the alternative for the construction of streets of any one or more different types of material and reserve the right of selection until after the bids are received.

For the purpose of hastening the work and securing competitive bids the city may improve its streets by districts by making each particular street, or each block of each particular street, the unit of construction.

SUFFICIENCY OF NECESSITY PAVING RESOLUTION OR ORDINANCE

The Oklahoma Supreme Court holds, Roberts v. City of Sapulpa, 242 Pac. 553, that the filing of a protest against a paving resolution is sufficient to put an end to the power of city authorities to proceed with the part of the improvement against which the protest is filed. After a first resolution for paving was thus protested down, a second was passed, and the paving was sought to be enjoined on the ground that the resolution used the words "cost of" instead of "pay for" as in the statute. It was held that although such a necessity resolution may be defective in detail, if it is published as provided by the statute and is sufficient to give the property owners notice, it is sufficient to give the city authorities power to make a valid contract for the paving.

CITY HELD ENTITLED TO DIVIDE PAVING IMPROVEMENT WORK AMONG CONTRACTORS AND TO PROVIDE FOR NECESSARY DRAINAGE

The Kentucky Court of Appeals holds, Janutola & Comadori Co. v. Taulbee, 277 S. W. 477, that, giving a liberal construction to Ky. St. §3571, giving cities full power over the improvement of streets, as provided by the act, a city of the fourth class may let a contract to one man to do one part of the improvement and to another to do another part. The city council also had the right, and it was its duty, to provide for the drainage of a street to be graded and paved although the ordinance said nothing about drainage, drainage being necessary to make a lasting improvement, and this being done in accordance with the city engineer's plans and specifications which were, by the ordinance, made a part thereof.

INTENTION TO WITHDRAW STREET FROM PUBLIC USE MUST BE SUFFICIENTLY SHOWN

The Missouri Supreme Court holds, Gerber v. Kansas City, 277 S. W. 562, that a city may temporarily withdraw all or a portion of a street from public use, and during such time incur no liability to persons, who, notwithstanding such withdrawal, use the street and are injured as a result thereof. But its intention to wholly exclude the public must be made unmistakably manifest; and merely permitting a lot of dirt to be piled into the street so that over the sidewalk and a good part of the street there was no traveling at all is not sufficient to close the street so as to protect the city from liability for injuries.

CITY MUST RETAIN SUFFICIENT SECURITY FOR LABOR AND MATERIALMEN ON STREET CONTRACT

The Massachusetts Supreme Judicial Court holds, J. H. McNamara v. McGuire, 150 N. E. 862, that a city required by Mass. Gen. Laws c. 149 §29, to take sufficient security to pay for labor performed or furnished and materials used in a street contract, cannot render what has been obtained as security under the statute insufficient by taking so much for itself that the remainder falls short of satisfying the statutory beneficiaries.

MUNICIPAL PARKS HELD "PUBLIC GROUNDS" WITHIN ACT REQUIRING THESE TO BE KEPT FREE FROM NUSIANCE

The Ohio Supreme Court holds, City of Cleveland v. Ferrando, 150 N. E. 747, that municipally owned and controlled parks, established and maintained for, and open to the general public, are "public grounds" within the meaning of that phrase in section 3714, Ohio General Code, and by that section the duty is imposed on municipalities to keep them free from nuisance. The presence of an unguarded unexploded bomb in a public park, left by a society which had obtained permission to explode fireworks in the park, was held a nuisance per se, and the municipality, having knowledge or actual or constructive notice thereof, was held liable for injuries to a child who lit the bomb.

CONSTRUCTION OF STATUTE MAKING MUNICIPALITY LIABLE FOR DEFECTS OF STREETS THROUGH MISMANAGEMENT

Municipal corporations are not liable in tort except by statute in the state of South Carolina. Civil Code 1922, §4478 authoritizes recovery for injury or damages caused by defects in streets or bridges if the defects result from the municipalities' neglect or mismanagement, in the absence of contributory negligence or the carrying by the injured person of a load exceeding the ordinary weight. The South Carolina Supreme Court holds, Stewart v. City Council of Charleston, 132 S. E. 678, that an allegation that the plaintiff, while in the city's employ, was injured when excavating on the street by the side of the excavation caving in, and alleging failure to provide a safe place for him to work on a public street, did not state a cause of action within the statute, there being nothing in the act showing an intention to make a municipality liable for any other mismanagement except in keeping the streets, etc., in proper and safe repair.

STATUTE OF LIMITATIONS AFFECTING WARRRANTS FOR STREET IMPROVEMENTS

The Washington Supreme Court holds, Perkins v. City of Ellensburg, 244 Pac. 996, that where city warrants payable out of special street and sidewalk funds were presented for payment and payment was refused for want of funds, the statute of limitations then began to run, and it was necessary for the holder of the warrants at some time within the statute of limitations affecting them to begin an action agaist the city or its officers to compel the levying of a tax to provide the funds. Action on such warrants, brought 36 years after their issuance, was barred, the longest time allowed by the state statute of limitations for the commence of any action being ten years, in the absence of any cause intervening to toll the statute.

MUNICIPAL CONTRACT FOR WATER SUPPLY IN ADVANCE OF NEEDS HELD NOT UNREASONABLE

The New Jersey Supreme Court holds,, New Jersey Suburban Water Co. v. Riordan, 132 Att. 318, that a contract by the mayor and common council of a town for a water supply is not an unreasonable or improvident exercise of power or a palpable abuse of discretion because made four years in advance of the expiration of an existing contract, nor because a proposition was subsequently received for a supply at a lower rate. The governing body may have considered it unwise to take the chance of obtaining a supply on short notice or at random.

EXTENSION OF CONTRACT TIME FOR EXCAVATION WORK

The Pennsylvania Supreme Court holds, McDonald Const. Co. v. Gill, 285 Pa. 305, 132 Att. 368, that a letter from the general contractor for the construction of a building to a sub-contractor for the excavation agreeing to exclude from the time for its completion such additional time as might be required by the sub-contractor in the performance of certain work which the general contractor had requested, accepted and approved by the sub-contractor and his sureties by writing thereon, constituted a written extension of the time provided in the original contract.

LOWEST BIDDERS ON GARBAGE REMOVAL CONTRACT ENTITLED TO HEARING BEFORE REJECTION OF BID

The New Jersey Supreme Court holds, Ianniello v. Town of Harrison, 132 Att. 78, that, assuming there is basis for discussing whether the lowest bidders on a garbage removal contract are properly equipped financially and materially to undertake and complete the work, they are entitled to reasonable notice and a hearing before their bid is rejected and a more burdensome contract imposed upon the taxpayers.

CITY'S DUTY AS TO FUNDS DUE CONTRACTOR IMPOUNDED BY SUB-CONTRACTORS' STOP NOTICES

The New Jersey Supreme Court holds, Linker v. Board of Education of Borough of Collingwood, 132 Atl. 84, that the provision of section 5 of the Lien Act of 1918, that the municipality "may" pay to the principal contractor funds due to him which have been impounded by subcontractors' and materialmen's stop notices upon his giving bond, is not mandatory on the municipality, but discretionary; and that to hold otherwise would deprive the municipality "of a substantial right to pay the money into court and wash its hands of the whole matter without being put to a reliance on indemnity bonds with the incidental risks inseparable from that sort of security."

CITY HELD NOT LIABLE FOR NEGLIGENCE OF EMPLOYEES IN MAINTAINING SWING IN PUBLIC PARK

The Connecticut Supreme Court of Errors holds, Epstein v. City of New Haven, 132 Atl. 467, that the control of public parks belongs primarily to the state, and municipalities in operating and managing them act as governmental agencies exercising an authority delegated to them by the state. The adaptation of public parks to serve in whole or in part as places of recreation for those who frequent them is a natural incident to their public use. "In the common understanding, a park, in this country, is a piece of ground in or near a city or town for ornament and as a place * * * for recreation and amusement, and it is usually laid out in walks, drives, and recreation grounds." (South Park Commissioners v. Montgomery Ward & Co., 248 Ill. 299, 304). For any negligence of its agents or employees in failing to guard against injury to children using a swing the support of which broke, the city was held not liable.

SUBSCRIPTIONS BY LANDOWNERS TO AID IN GRAVELING COUNTY ROADS

The Kansas Supreme Court holds, Board of County Court of Neosho County v. Burdick, 244 Pac. 866, that, although under the statutes, a county is required to improve an authorized county road, it is not required to surface it with gravel. There is, however, no statute preventing adjoining landowners making a subscription to help pay the cost of such improvement. One who petitions a board of county commissioners to surface the road with gravel and agrees to pay a definite sum to aid in paying the cost, cannot, after the improvement is made, be relieved from paying his subscription on the ground that the agreement was ultra vires on the part of the county. Moreover, subscriptions to public or quasi public corporations, to enable them to construct or maintain public improvements, are usually upheld without a statute specifically authorizing the corporations to make such agreements unless such subscriptions are prohibited by statute, or are in contravention of public policy.

CITY'S POWER TO GRANT FRANCHISE FOR WATERWORKS

The New Mexico Supreme Court holds, Asplund v. City of Santa Fe, 244 Pac. 1067, that, under the New Mexico statutes, a city may by ordinance grant a franchise to maintain and operate an existing waterworks system and to make additions, extensions and betterments thereto, without first submitting the question to a vote of the people.

NEWS OF THE SOCIETIES

March 2-4 — CANADIAN SECTION, AMERICAN WATER WORKS ASS'N. Meeting at Ottawa.
March 25—NEW JERSEY SEWAGE WORKS ASS'N. Annual meeting at State House, Trenton.
April 12-13—AMERICAN WATER-WORKS ASS'N, FLORIDA SECTION. Second meeting at Hollywood, Fla.
April 26-28—SOUTHEASTERN WATER AND LIGHT ASS'N. Convention at Jackson, Miss.
April — SOUTHEASTERN WATER AND LIGHT ASS'N. Convention at Jackson, Miss.
May 2-4—NATIONAL CONFERENCE ON CITY PLANNING. Annual conference at Washington, D. C.
May 9-12—NATIONAL FIRE PROTECTION ASS'N. Annual meeting at Chicago, Ill.
June 6-11 — AMERICAN WATER WORKS ASSOCIATION. 47th annual convention at Chicago, Ill.
September—CITY MANAGERS ASSOCIATION. Fourteenth annual convention, Dubuque, Ia.

ASSOCIATION OF HIGHWAY OFFICIALS OF THE NORTH ATLANTIC STATES

The third annual convention of this association was held at Atlantic City, N. J., February 16-18, 1927, with about fifteen hundred in attendance. At the morning session of the first day, after the speeches of welcome, J. G. McKay of the Bureau of Public Roads, spoke on "Traffic Surveys." He stated that a highway department without a thorough knowledge of present and expected future traffic on its highways is lacking one of the basic essentials necessary for a comprehensive plan of highway development. Such a survey enables a department to know the present and future importance of its roads, and the weight, density and importance of traffic to which they are likely to be subjected.

John A. MacDonald, commissioner of highways of Connecticut, at the afternoon session, declared the automatic light signal a detriment rather than an aid in the solution of traffic congestion, and recorded himself in favor of the use of policemen to replace lights at more important places.

Highway economics were discussed at the Thursday morning session by Fred Lavis of the New Jersey State Highway Department. Mr. Lavis went very fully into the matters of grade, curvature, rise and fall, reduction in length and similar factors. His paper was discussed by L. D. Brownell, division engineer of the New York Bureau of Highways, who stressed the factors of safety in road design—width, curvature, banking of curves, clear vision, and grade and traffic crossings.

"Report on Observations on Concrete Pavements Under Various Specifications and Conditions Imposed in the North Atlantic States," was the title of a paper by J. S. Bixby, division engineer of the New York State Bureau of Highways. In a most interesting and complete paper, Mr. Bixby touched on materials and mixes, reinforcement, width, thickness, and condition of subgrade. His paper was discussed by C. D. Buck, W. M. Acheson, C. F. Bedwell, and H. E. Breed.

The entertainment feature of the convention was a Smoker held at the Hotel Ambassador, Thursday evening. The Friday morning session was a general discussion of problems and projects by states. In the afternoon, Paul D. Sargent, chief engineer of the Maine State Highway Department, told of his observations in European highways and of his impressions at the National Road Congress. Later there were committee reports and a business meeting.

Officers of the association are: President, A. W. Brandt, State Highway Commissioner of New York; vice-president, C. D. Buck, chief engineer of the Delaware State Highway Department; secretary and treasurer, A. Lee Grover, secretary of the New Jersey State Highway Commission.

INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS

The St. Louis meeting of this association on January 10th and 11th was attended by 78 delegates from different parts of the country extending from Massachusetts to California. The new officers elected were as follows: President, Theodore Eichhorn, Erie, Pa.; first vice-president, G. R. Thompson, Detroit, Michigan; second vice-president, Elmer C. Goodwin, New York City; third vice-president, A. B. Cook, Charlotte, North Carolina; treasurer, A. J. Paul, Ann Arbor, Michigan; secretary, A. M. Anderson, Chicago, Illinois. The Board of Governors consist of Lester W. Herzog of Albany, New York, representing the First District; H. W. Fledderman of Louisville, Ky., Second District; Matt S. Murray, Kansas City, Missouri, Third District; F. J. Altvater, Denver, Colorado, Fourth District; W. C. Earle, Pasadena, California, Fifth District; and E. A. Wood, Winnipeg, Canada, Sixth District; also past president W. J. Galligan of Chicago.

ENGINEERS' CLUB OF PHILADELPHIA

A meeting of the Engineers' Club of Philadelphia was held February 15 on the general subjects of strengthening foundations for highways and city streets to meet the growth of motor bus and truck traffic and the most economical method of effecting the strengthening. Papers at the afternoon meeting were on the general subject of existing conditions. The speakers were J. H. Neeson, Chief of the Bureau of Highways of Philadelphia; R. A. MacGregor, Engineer of Maintenance, Borough Manhattan; C. B. Hunt, Engineer of Highways, Washington, and F. W. Lyon, Chief Engineer of the Department of Public Works of Pittsburgh. Mr. Neeson, after surveying the growth and development of pavement construction in Philadelphia, devoted some time to the discussion of causes of failures of concrete bases. The causes were attributed to inadequate subgrade preparations, imperfect and improper replacement of ditches and service cuts, inferior concrete, and failure of the top surface, or its inability to perform its proper function. A survey by the Philadelphia Bureau of Highways, in which twenty-seven openings were made, showed failure due to surface failures in eight cases, from improperly tamped ditches in four cases, from poor subgrade in three cases, and in two cases the base was shattered, evidently due to surface impact.

R. A. MacGregor stated that while in New York standard thickness of base was 6 inches, the foundation is made 9 inches thick on streets with heavy traffic, either present or reasonably expected. A 9-inch base gives approximately twice the strength of a 6-inch base at 50 per cent greater cost.

At the evening session F. H. Jackson, Engineer of Tests, Bureau of Public Roads, discussed quality control of concrete, including a review of the impact studies made by the Bureau of Public Roads. He stated that, in his belief, tax construction methods of the past are responsible for most of the poor concrete found today, and urged standardized methods for the productions of good concrete of uniform quality. Dirty materials, inaccurate measuring, undermixing, too much water, poor finishing and inadequate curing were charged as important reasons for past failures. All of these causes are possible only because of inefficient or dishonest inspection.

P. M. Tebbs, of the State Department of Highways, told of studies carried on by the Pennsylvania highway department on pavement slabs and methods of strengthening foundations.

INDIANA SECTION, AMERICAN WATERWORKS ASSOCIATION

The 20th annual meeting of the Indiana Section, American Waterworks Association was held at Indianapolis, February 17 and 18. State Senator L. C. Bradford was not present, but his subject was discussed by Dr. W. F. King, secretary of the Indiana State Board of Health. The Izaak Walton League, cooperating with the State Board of Health has prepared for enactment by the State Legislature, now in session, a bill regulating the control of steam pollution, very similar in its provisions to that at present in force in Ohio. The bill has, however, been so emasculated that even if enacted it will be practically useless. It is understood that a clause has been included exempting Lake County from such of the provisions as remain. Lake County is the county bordering on Lake Michigan, in which are located Hammond, Gary, Whiting, East Chicago,—all of which comprise a highly industrialized area from which considerable pollution is discharged into Lake Michigan. Dr. King also discussed the data obtained in a sanitary survey of a section of the White River, the stream from which Indianapolis obtains its water supply. The Indianapolis Water Co., the State Board of Health, and the Indianapolis Sewerage Commission cooperated in collecting samples and making analyses of various sections of the river over a considerable period of time to ascertain the degree of pollution at various points along the stream. While the report of this work has not yet been completed, Dr. King described the salient features that were observed as a result of this study.

(*Continued on page 44*)

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

"SEETHRU" SIGNS

The Essco Manufacturing Company, Peoria, Ill., manufactures signs which are made brightly visible at night by lights from street lamps shining through them. The sign is located at the curb line and the rays of the street lights at the back are collected by lenses set in the letters of the signs and the rays are then transmitted from the front of the sign to the drivers in the street. The sign is built of heavy steel approximately 3-32 inch thick,

A "SEETHRU" SIGN

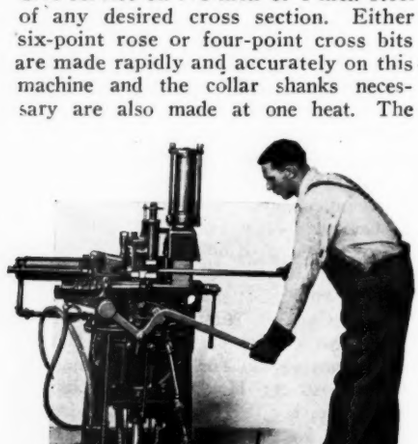
provided with a reinforcing rib around the entire sign and has holders for the lenses and a pipe socket welded to the back. The back and front are painted Federal yellow with black lettering in accordance with the recommendation of the Hoover Conference. The sign is to be located so that a street light is back of or back and to one side of the sign. A two-inch pipe is driven into the ground and the sign is fastened to the top of the pipe with set screws. The signs are furnished with illluminated words "Slow" or "Stop" and with painted legends, for "through streets," "boulevard crossing," "arterial highway," "state highway," "police order," etc.

THE TAL-FLO MIXER

The Talbot-Flood Mfg. Co., Kansas City, Mo., manufactures a mortar mixer which it calls the TAL-FLO for which it claims as special features, paddles working in opposite directions; no axle through the drum; quick and easy unloading device; passing through a 2 ft., 6 in. door opening; Timken roller bearings; Alemite oiling system. The paddles work in opposite directions, throwing and cutting the material quickly and, running ⅛ of an inch from the sides and end, clean the hopper with every batch. It is built in three sizes—4 cubic feet, 7 cubic feet and 14 cubic feet and is equipped with electric motors or gasoline engines. A three horse power motor is used with the 4 cubic foot mixer and a 15 horse power with the 14 cubic foot mixer.

SULLIVAN LIGHT DRILL SHARPENER

The Sullivan Machinery Co., Chicago, Ill., recently brought out the Sullivan Class "C" light drill steel sharpening machine operated by compressed air. The class "C" sharpener is intended for making uniform and accurate bits and shanks for hammer-drill service on 7/8-inch or 1-inch steel of any desired cross section. Either six-point rose or four-point cross bits are made rapidly and accurately on this machine and the collar shanks necessary are also made at one heat. The



SULLIVAN CLASS C DRILL SHARPENER

class "C" sharpener is also equipped to forge pick point bits and collar shanks on 1⅛-inch concrete breaker steel or to put shanks on steel spades used in the Sullivan "Spader." This sharpener weighs only 1100 pounds and occupies a floor area of 2½ x 3½ feet, yet is sufficiently powerful and so well made that it does a real job for the contractor or quarry-man or even for smaller mines in keeping drill steel in perfect condition. All operations on the steel are performed by the Sullivan "All-Hammer" method at relatively low heat, so that the steel runs no danger of being burned or otherwise injured in the process of sharpening.

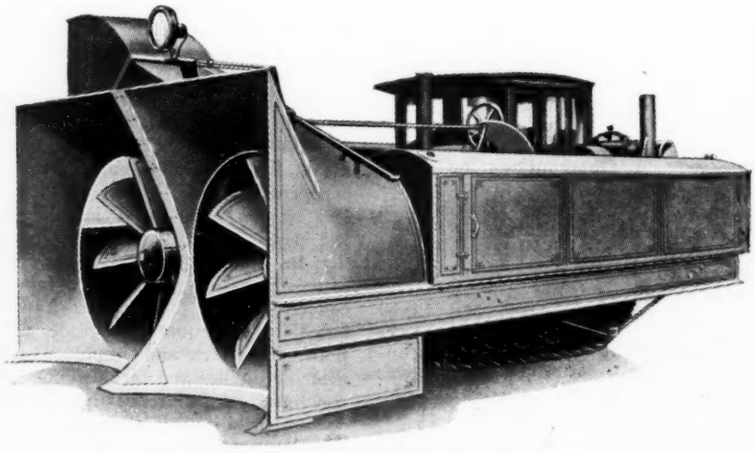
ARKSAFE LININGS

The Arkell Safety Bag Co., New York, N. Y., manufactures an elastic paper bag lining, which is made from paper which will stretch about one-third. Arksafe linings are also waterproof and therefore of great value in shipping materials that are objectionably affected by moisture. They are made to fit all sizes of bags, and are used in shipping all kinds of granular, pulverized, and powdered materials.

BAG LINING

EDWARDS ROTARY SNOW PLOW

In the model C rotary snow plow manufactured by the C. L. Edwards Mfg. Co., Inc., Albert Lea, Minn., the two rotors are operated by separate 110 horse power motors, so arranged that either rotor can be run separately, if desired. Exhaust snow is thrown to one side of the road by centrifugal force, and is deposited two to three hundred feet away, even against a severe wind. The driver can control the depth of cut from the tractor seat, and can raise the front end of the plow from the ground to a height of 2 inches in 30 seconds. Unusual flexibility and stability are claimed. The plow can turn in its own length, while the center of gravity is very low, eliminating the tendency to ride over the drifts. All the weight of the plow is



EDWARDS MODEL "C" ROTARY SNOW PLOW

distributed uniformly on the two tractor trucks, no weight being placed on the tractor frames. The plow is operated by one man only, whose principal duty is to drive the tractor. Automatic governors on the snow plow motors control the amount of gas furnished with varying snow loads. There is a safety pin shearing device on each rotor which protects the drive against damage through logs, rocks, or heavy overloads. New shear pins are replaceable in three minutes.

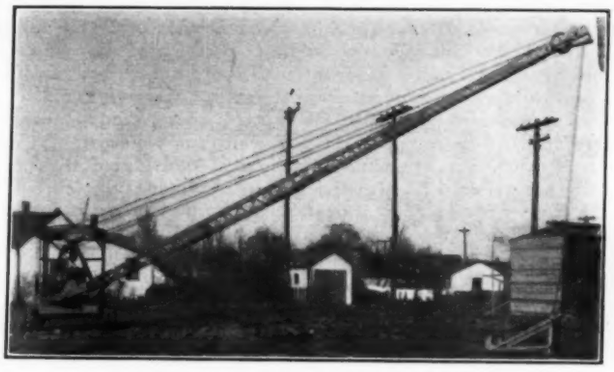
The tractor motor is used for no purpose other than driving the tractor. Independent motors drive each rotor, allowing independent operation and making the plow especially valuable for widening work. On account of the absence of any wedge shape at the front, it is claimed that all side draft is eliminated.

ZENITH FUEL FILTER

The Zenith-Detroit Corporation, Detroit, has developed a fuel filter adaptable for use with the Stewart-Warner vacuum tank. The filter unit consists of 200 thin brass washers and spacers which filter the gasoline through openings of 3½ thousandths of an inch, which are one-third the size of the openings in ordinary 60-mesh gauze. Troubles incident to the use of gauze and leather filters are eliminated. The unit is claimed to be indestructible and can be cleaned easily in a few minutes. Impurities are extracted from the fuel and collect on the outside edges of the washers, where the swirling of the gasoline, when the car is in motion, washes it away. There is a large area of available filter surface, which eliminates trouble from restriction of flow due to clogging, if this should occur.

INSLEY EXCAVATOR IMPROVEMENTS

The Insley Mfg. Co., Indianapolis, Ind., announces several improvements in its type "C" Excavator. One of these is a completely enclosed steel cab equipped with swinging windows and sliding steel panels which permit light for the operator and complete accessibility to every working part and at the same time give maximum protection to the machinery. Another improvement is the adoption of one-shoe lubricating system to crawler rollers. With this system it is not necessary for the operator to leave his seat to oil the rollers, this system being controlled by a cylinder and plunger mounted in front of the control lever within easy reach of the operator's seat. The company also announces an addition to its line in the form of a backfiller attachment with a 30-40 telescopic boom which can be extended to a length of 50 feet by the addition of a 10-foot intermediate section.



INSLEY EXCAVATOR WITH BACKFILLER ATTACHMENT

HORN'S "NO-FREEZE"

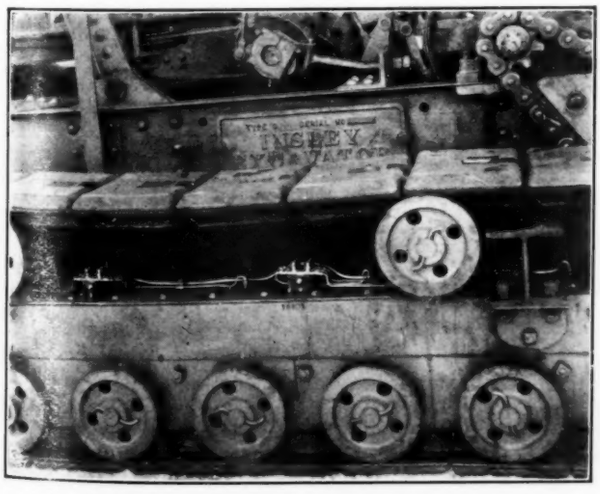
The A. C. Horn Co., Long Island City, New York, manufactures a liquid material which it calls "No-Freeze," the object of which is to prevent the freezing of concrete when laid in temperatures at or below 32 degrees. For temperatures of 37 degrees to 32 degrees they recommend one gallon of "No-Freeze" to 15 gallons of the gauging water; 1 gallon to 12 gallons of water for temperatures down to 28 degrees; 1 gallon to 9 gallons of water for temperatures of 28 to 23½; and 1 gallon to 8 gallons for temperatures down to 22 degrees. They do not recommend using it below 22 degrees, as below this temperature no addition to water will prevent its freezing and generally the men will not work. For work under such conditions, tarpaulins or salamanders should be used.

It is explained that "No-Freeze" undergoes a chemical reaction which releases heat and lowers the freezing point of the water; and that in addition to this it also causes the concrete to flow more readily, requiring less puddling or ramming, and also hastens the set of the concrete so that the opportunity for freezing is reduced.

HARNISCHFEGER LIGHT EXCAVATOR

In answer to the many requests by contractors for a small, light excavator, the Harnischfeger Corporation has just brought out a new ½ cubic yard capacity machine called Model 300. These machines are built especially for the contractor who specializes in small jobs, such as basement excavation, etc., where exceedingly short tail swing, ability to travel in close quarters, power, speed and reliability are deciding factors. The model 300 has a tailswing of 7 feet, 1½ inches, a swing speed of 5¼ R.P.M., is powered with a 50 H.P. gas motor, and has a hoist independent of the swing, and a corduroy that can be turned in the tightest places. It can be used with the following attachments: shovel, dragline, clamshell, crane pile driver or magnet. For clam service, etc., it is equipped with a 30 ft. boom. Like all larger P. & H. models, this model 300 is also equipped with the P. & H. patented power clutch control. Only 4½ pounds pressure is required to work the levers—the motor does the rest.

Another feature is the 100% foolproof boom hoist braking system. In addition to a foot operated band brake and a pawl and ratchet for holding the boom in a fixed position, there is a lowering control load brake which positively prevents the boom from dropping. The Harnischfeger Corporation states that this load brake has



LUBRICATING SYSTEM FOR INSLEY CRAWLER ROLLERS

HARNISCHFEGER LIGHT EXCAVATOR

been used on P. & H. electric overhead cranes for over 30 years and has never failed. The corduroy construction is built along the same general lines as those which have proved such a success on the larger models. The carbody is of large proportions, well braced, with the traveling machinery easily accessible. The revolving frame is a heavy one-piece, annealed steel casting, extending from boom hinge to the extreme end of machine. Other details are described in Bulletin 650X.

AUTOMATIC ALTERNATOR FOR PUMPS

The Chicago Pump Company, Chicago, Ill., has recently introduced a device called the automatic alternator to be used in conjunction with duplex units of vertical centrifugal pumps which the company believes is the most practical device so far developed to alternate the operation of duplex vertical sewage ejectors and bilge pump equipment. It is especially designed to automatically alternate the operation of each pump in a duplex unit, the work being shifted automatically from one pump to the other without the equipment being touched by the operator. It also automatically starts the pump not in operation in the event the pump in operation fails or is not able to handle all the water. During an emergency or when the amount to be handled exceeds the capacity of one pump, both pumps will automatically cut in and continue to operate until normal conditions are restored, when they will resume their alternate operation.

THE WAUSAU SENIOR SNOW PLOW

The Wausau senior snow plow, manufactured by the Wausau Iron Works, Wausau, Wis., is especially designed and built for use under adverse conditions of long winters and heavy snowfall. The design of the moldboard is such that the snow is rolled, not pushed, thus securing maximum result under minimum effort and strain. This plow is easily adjustable. The blade can be set to clear the snow down to the road bed, or any desired depth of snow up to 12 inches may be left on the road. The plow is carried on combination runners and wheels, thus insuring easy movement on snow, ice, bare pavement or gravel. To obtain increased traction for the tractor, either part or all of the entire weight of the plow may be carried on the tractor. Wings, which are raised or lowered by quick acting triplex chain hoists, independently of each other, and to a height of five feet in thirty seconds, give the plow an overall width when fully extended of 22 feet. The moldboard is so designed, and the method of attachment to the tractor is such that all or only half of the moldboard width can be used without objectionable side draft. A valuable feature of this plow is the forward position of the tractor, which has much to do with the elimination of side draft troubles.

THE GARFORD 30 TRUCK

The Garford Truck Company, Lima, O., claims for its new Model 30 1½ and 2-ton truck stream lines and attractiveness resulting from newly designed radiator and hood, crown fenders, straight line frame and pneumatic tires; ruggedness and dependability resulting from powerful engine, heavy frame and sturdy worm-drive rear axle; efficiency and operating economy resulting from improved cooling, electrical equipment, air cleaner and fewer servicing parts. It has greater speed than the old model, improved steering apparatus, comfortable seat, lower chassis with correspondingly lower loading height, and complete electrical equipment.

The new Model No. 20, a 1-ton truck, was first shown at the New York Automobile Show opening January 8th. The principal features are a speed range from 15 to 50 miles an hour; low loading height, the frame being only 26 inches from the ground; increased safety through larger brake drums on the rear wheels and a new and finer spiral bevel gear rear axle; increased driving comfort, resulting from use of cab designed along lines of passenger car coupe body; and steering ease approaching that of a passenger car.

The wheel base is 136 inches on the standard chassis and 156 on the long. The engine is of 4-cylinder type, 22½ h. p., cast en bloc with detachable head. The cylinders are 3¾ by 5⅛ inches. If additional speed, flexibility and ease of handling are desired the purchaser may have, at a slight increase in price, a 6-cylinder engine of 27.3 h. p., 3⅜ inch bore and 4½ inch stroke. The flywheel is fully enclosed, the fan, magneto drive and water pump drive being the only exposed moving parts. Lubrication is forced feed, a gear-driven pump delivering oil to the crankshaft main bearings and to the timing gear compartment. The wheels are supported on roller bearings which absorb all end thrusts of the differential. Electrical features include generator, starting motor, headlights with dimmers, instrument panel light and tail light.

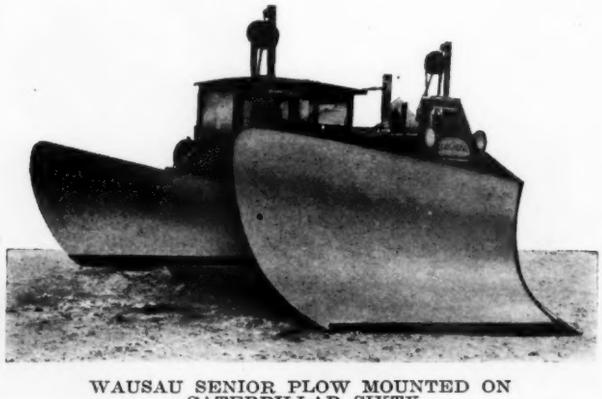
FLEXIBLE ROAD JOINTS

The Flexible Road Joint Machine Co., Warren, O., manufactures a machine which will install mechanically transverse and longitudinal joints in concrete roads. It is claimed that transverse joints installed by this system will eliminate entirely transverse contraction cracks in the concrete, and that, as a result, it is possible to construct what is called a "flexible" concrete road. Such a road, it is stated, will not fracture either transversely or longitudinally. Both longitudinal and transverse joints in the demonstration road on Lee Highway, Virginia, were installed by this machine.

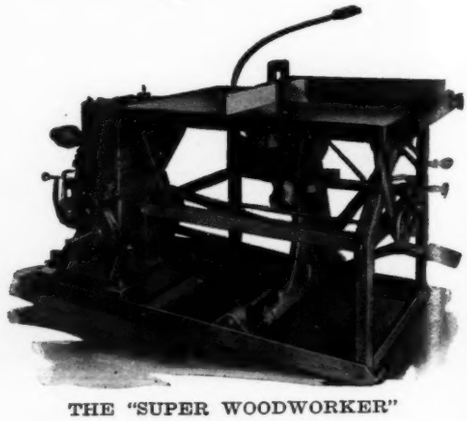
SUPER WOODWORKER

Jones Superior Machine Co., Chicago, Ill., makes a saw rig for contractors which it calls the Super Woodworker. It consists of a circular saw set in a swinging arbor, with a table made of heavy steel containing a long wooden throat piece fitted in same, which can be tilted to 45 degrees. The recommended speed is 10,000 feet per minute which leaves a very clean cut. The swinging arbor is equipped with both hand and foot lever. Each machine is equipped with a 14-inch rip saw and a 14-inch cross-cut saw. It can be operated by gasoline engine, electric motor or counter shaft. The gasoline engine regularly furnished is the Le Roi.

Among the points emphasized by the makers are the advantage of the tilting table for bevel ripping and making miter cuts; the table top is Parkerized to make it rust proof; Timken roller bearings are installed on all moving parts and the machine has Alemite lubrication. It is strong, but light enough to be portable.



WAUSAU SENIOR PLOW MOUNTED ON CATERPILLAR SIXTY
Note far forward position of tractor in plow



THE "SUPER WOODWORKER"

NEW CATALOGS

PLASTER STUCCO REINFORCEMENT

The American Steel and Wire Co., Chicago, Ill, a 6-page illustrated folder describing galvanized electric welded plastic stucco reinforcement, with methods of application.

MONARCH TRACTORS

The Monarch Tractors Corporation, Springfield, Ill., has just published a catalog describing the Model F, 10-ton tractor.

WESTEECO DIPPER TEETH

The Western Crucible Steel Casting Co., Minneapolis, Minn., in a 4-page illustrated folder describes its line of dipper teeth, especially designed for use in hard digging.

SOLVAY CALCIUM CHLORIDE

The Solvay Process Co., Syracuse, N. Y. A 32-page booklet describing the use and advantages of calcium chloride in the curing and hardening of concrete roads.

EXPANSION JOINTS

The Servicised Products Corporation, Chicago, Ill. An illustrated, 40-page catalog describing their expansion joints and related products for use in concrete road construction.

DUZIT AGITATING SCREEN

The Duzit Agitating Screen Co., Cedar Rapids, Ia., a 4-page folder describing the construction of their agitating screen designed for screening gravel, sand, crushed stone, etc.

GATES FOR SAND, STONE AND GRAVEL

The R. H. Beaumont Co., Philadelphia, a 16-page booklet describing Beaumont simplex and duplex gates for handling sand, stone, and gravel.

"KYROCK"

The Kentucky Rock Asphalt Co., Louisville, Ky., a 32-page booklet, "The Story of Kyrock," from the hills of Western Kentucky to the finished pavement.

SKIMMER-DITCHER

Bay City Dredge Works, Bay City, Mich. Folder describing the 16-B Bay City heavy weight skimmer-ditcher, with photographs showing its many economical uses.

FOR THE ROAD MAKER

Good Roads Machinery Co., Kennett Sq., Pa. An eight-page catalogue, describing, with illustrations, distributors, road rollers, crushers, car unloaders, motor graders, road graders, and culverts.

ROAD MACHINERY

The Galion Iron Works and Mfg. Co. Galion, O. An elaborate 96-page catalog describing a wide line of road machinery. Also a 4-page folder describing a leaning wheel grader, and a 12-page catalog describing the Galion International Roller.

EXCAVATING AND MATERIAL HANDLING

Bay City Dredge Works, Bay City, Mich. A folder describing the Bay City Tractor Shovel, with photographs, and specifications and details of construction.

FLEX-PLANE ROAD JOINTS

The Flexible Road Joint Machine Co., Warren, Ohio, a 16-page illustrated catalog showing Flex-Plane joint in use on many road jobs, and describing in detail their value and method of installation.

ELECTRICAL ENGINEERING ACHIEVEMENTS

Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. A 44-page illustrated pamphlet listing the notable 1926 achievements of the Westinghouse organization.

AUTOCAR ROAD BOOK

The Autocar Co., Ardmore, Pa. The seventh annual edition of the Autocar Road Book contains 36 pages largely given over to illustrations showing Autocars in use on highway and paving work.

YELLOWCAB TRUCKS

The Yellow Truck & Coach Mfg. Co. of Chicago, Ill., has announced that early in 1927 it will begin the marketing of one- and two-ton motor trucks equipped with the Buick 6-cylinder engine. All trucks will be equipped with self-starters, extra-heavy truck type axles, and, on the 2-ton models, four-wheel brakes will be standard. The chassis will be sold with or without bodies.

The one-ton model T-20, with a chassis road weight of 2,750 pounds, will have a wheelbase of 132 inches. The two-ton model T-40, with a spiral bevel axle and pneumatic tire equipment has a chassis road weight of 4,325 pounds and will be furnished in three wheelbases, 136-inch, 150-inch, and 162-inch. The two-ton model T-50, with a worm axle and solid tires, will have a chassis road weight of 4,630 pounds, and will have the same wheel bases as the model T-40. The one-ton chassis is equipped with the standard Buick 6-cylinder engines, 3⅛-inch bore and 4½-inch stroke, piston displacement 207 cubic inches, S. A. E. horsepower rating 23.4. In the models T-40 and T-50 the Buick master 6-cylinder engine, 3½-inch bore and 4¾-inch stroke is used. The piston displacement of this engine is 274 cubic inches and the S. A. E. rating 29.4.

Tires on the T-20 are 30x5, front and rear, with provision for oversizing with 32x6 truck commercial. On the T-40 front tires are 32x6 and rear 34x7 pneumatic, but dual rear are also furnished. Solid tires on the model T-50 are 34x4 front and 34x7 rear. Metal spoke type wheels are used on the T-20; on the other models 8-spoke cast steel are standard, with disc wheels optional on trucks with dual rear pneumatic tire equipment.

Equipment is very complete, including Delco starter and generator, ammeter, oil gauge, and speedometer. The tire carrier is in the rear under the frame.

INDUSTRIAL NOTES

SIXTH ANNUAL ELECTRIC SIGN SHOW

More than two hundred electric signs and electric advertising devices of all kinds were displayed in the sixth annual Electric Sign Show, held in The New York Edison Company's showrooms at Irving Place and Fifteenth Street, February 14 to 19. The two hundred signs were products of more than sixty manufacturers all over the United States; they include practically every type of electric device for attracting attention by means of motion or light.

CATERPILLAR TRACTOR REPORT

The annual report of the Caterpillar Tractor Co., for 1926, in addition to the presentation of financial items of interest to stockholders, stated that more Caterpillar tractors were sold in 1926 than in any preceding year. Prices here have been reduced, and the field for use broadened. Caterpillars are now used in a great variety of work, including, in the public field, road construction and maintenance, snow removal and ash and garbage removal.

FULL-CRAWLER COMPANY CHANGES NAME

The Full-Crawler Co., 500 Clinton street, Milwaukee, Wis., announces the change of its name to the Trackson Company, by which it will be known in the future. The change was made in order that the company's dealers, customers, and other friends may more easily link the company name with that of its product, the Trackson Full-Crawler for the Fordson Tractor. The Trackson Company remains a division of the George H. Smith Steel Casting Company, and retains the management, organization, and personnel of the former Full-Crawler Company.

BELLE CITY MANUFACTURING CO.

At the annual meeting of stockholders of the Belle City Manufacturing Co., Racine, Wisc., Stephen Bull was elected president, Harry S. Reed, vice-president and general sales manager; Walter J. Tostevin, secretary, and George A. Nelson, assistant secretary and assistant treasurer. The outlook for 1927 was reported as very favorable, with more than 150 per cent increase over last year, since the beginning of the company's fiscal year, November 1. A considerable part of the sales are for export trade.

"MACCO" SWEDISH STEEL

P. F. McDonald & Company, of Boston, Mass., are the sole U. S. agents for "Macco" Brand Swedish hollow and solid drill steel. They are now in position to furnish this steel in tools made up for use in the public works field, including concrete and paving breakers, steam drills, plug drills, granite points, hand and track chisels, wedges and skims. Hollow and solid drill steel in bars is also furnished.

NEW ASPHALT ASSOCIATION BRANCH MANAGER

William H. Rhodes, maintenance engineer for the Oklahoma State Highway Department, formerly with the United States Bureau of Public Roads and the Louisiana State Highway Department, has been appointed manager of the Asphalt Association's Southern Branch at New Orleans. Mr. Rhodes entered upon his duties March 1st.

DRY CHLORINE GAS STERILIZATION PATENT

On January 29th, District Judge Hazel of the western district of New York handed down a decision with reference to the Darnell Patent for the sterilization of water and sewage by the use of chlorine as a dry gas. This is a patent dated October 31st, 1911, and owned by Wallace and Tiernan Company, which brought suit against the village of LeRoy for apparatus which was used by that village, having been installed by the Paradon Engineering Company. The court held that claims one, two and four of the patent were infringed by the village of LeRoy, and the Paradon Engineering Company as a contributary infringent, and that a decree will therefore run against both in favor of the plaintiff for an injunction and accounting for costs.

LAKEWOOD ENGINEERING CO.

The Lakewood Engineering Company, Cleveland, O., announces the appointment of the Superior Supply Company, Webster Building, Chicago, as distributors of its equipment in the river counties of Iowa, Northern Illinois and the northwest portion of Indiana. A. N. Herrick, manager of the Chicago office now closed, continues as district supervisor of the central west territory with headquarters with this company.

HARNISCHFEGER FLORIDA OFFICE

The Harnischfeger Corporation, Milwaukee, Wis., successor to Pawling & Harnischfeger Company, announces the removal of its branch office at Jacksonville, Fla., from the Peninsular Casualty Bldg., to 509 East 8th Street. F. W. Truex is branch manager in charge. After March 1st, the Jacksonville branch warehouse will be moved from its present location, 1465 Kings Road to 509 East 8th Street, thus combining the office and warehouse and affording better service to users of P & H equipment.

KONSET FOR WEST PALM BEACH

The Sullivan Co., of Memphis and Montreal, states that the company recently sent by express a carload of 'Konset" to West Palm Beach, Fla., on a wire order, to be used on the Dixie Highway and city streets to quicken the set of the concrete used therein so that the territory could be opened to traffic as soon as possible. The city manager stated that he opened up the principal streets to traffic in 36 hours by use of that material.

BULL & ROBERTS PARTNERSHIP

Alvin C. Purdy has been admitted as a general partner to the firm of Bull & Roberts, chemical experts, 50 West Street, New York.

GENERAL MANAGER FOR INDIANA TRUCK

J. W. Stephenson, president of the Indiana Truck Corporation, Marion, Ind., announces that A. S. More has recently become vice-president and general manager of the company. With the appointment of Mr. More, Mr. Stephenson can devote more of his time and attention to various business and financial interests.

HIGH EARLY STRENGTH CONCRETE

The Lehigh Portland Cement Co. has published a folder giving information concerning the equipment, materials and methods needed for high early strength concrete. These factors are stressed: long mixing time, low water content, and increased Portland cement content.

J. D. ADAMS & COMPANY TAKES OVER SALE OF STROUD ELEVATING GRADERS AND WAGONS

Announcement is made that J. D. Adams & Company has taken over the exclusive United States and Canadian sales rights to Stroud Elevating Graders and Dump Wagons. These products will now be sold by the Adams sales organization, consisting of direct factory sales representatives and distributors throughout the United States and Canada, with branches in Spokane, Minneapolis, Kansas City, Dallas, Memphis, Harrisburg, Winnipeg and Toronto.

BUFFALO TRADE NEWS

C. F. Weaver and M. J. McNamara have become associated in the business of representing trade publications in Buffalo, under the name of "Buffalo Trade News."

CHEMICAL TOILET CORPORATION'S NEW PLANT

The Chemical Toilet Corporation, Syracuse, N. Y., manufacturers of metal septic tanks and chemical toilets, has moved into its new factory. The new plant has a capacity about twice the old one, and the move was necessitated by the great increase in business during the past two years.

KENNEDY VALVE MFG. CO.

The Kennedy Valve Mfg. Co. is now celebrating its fiftieth anniversary, still under-active charge of Daniel Kennedy, the founder. The company started in New York, moved to Coxsackie, N. Y., to a larger plant; outgrew this plant, and then moved to Elmira, N. Y., where it now occupies two large plants, covering a total of 35 acres. At present, the Kennedy line covers a wide range of valves for standard and special requirements, as well as pipe fittings and fire hydrants.

NEWS OF THE SOCIETIES

(Continued from page 37)

J. K. Hoskens, Sanitary Engineer, U. S. Public Health Service, reviewed a report of the study of the pollution of Southern Lake Michigan in the vicinity of the Calumet River and Indiana Harbor. Paul Hansen spoke on the coordination of sewage disposal and water purification.

At the Plant Operators round table luncheon, held at noon, February 17, it was unanimously agreed by the Section to establish in Indiana an annual conference or school for the benefit of operators of water purification plants and of water works. A committee was appointed to formulate plans for inaugurating this school next year. L. S. Finch, engineer of the water and sewage department, Indiana State Board of Health, was designated as the secretary of this committee, to arrange for the details of the organization.

Papers at the afternoon session included, J W. Moore, Consulting Engineer "The Economic Limit to Deep Well Production"; W. C. Mabee, Acting Chief Engineer of the Indianapolis Water Co., "Concrete Handling Methods in Reservoir Construction"; Geo. W. Booth, Chief Engineer of the National Board of Fire Underwriters, "Fire Prevention"; A. M. Hogston, Indiana State Fire Marshal, "Fire Prevention Work in Indiana.'

Friday morning program included papers by Charles Brossman, Harry O. Garman, J. J. Daniels, and A. E. Gorman. W. H. Durbin who was scheduled for a paper was unable to appear because of illness.

The Friday noon luncheon was well attended. There were addresses by Mayor J. L. Duvall, and by Dick Miller, president of the Chamber of Commerce. At the final session, there were papers by C. S. Bennett, Chester C. Oberleas, R. B. Wiley, and L. S. Finch, the latter on "Rating of Purification Plants," evoking considerable discussion.

NORTHEASTERN SECTION, A.S.C.E.

At the annual meeting of the Northeastern Section, American Society of Civil Engineers, on January 29th, the following officers were elected for the ensuing year: President, J. C. Moses; Vice-President, S. H. Thorndike; Secretary-Treasurer, C. W. Banks. Executive Committee: J. L. Howard and D. M. Wood.

LOUISIANA ENGINEERING SOCIETY

Edward S. Lanphier, superintendent of the Eighth Lighthouse District, was elected president of the Louisiana Engineering Society at a meeting held recently in the Louisiana State Museum Building at New Orleans. Other officers elected: John L. Porter, vice-president; Frank A. Muth, secretary; Walter B. Moses, treasurer, and James M. Todd, to serve as director for three years.

AMERICAN WATERWORKS ASSOCIATION

The 47th annual convention of the association will be held in Chicago, Ill., June 6-11, 1927. A program of unusual interest to waterworks, superintendents and commissioners, city engineers and managers, sanitary, consulting and fire prevention engineers, and others engaged or interested in water supply is promised. Entertainment features for the delegates and ladies are being planned. Railroad rates of one and a half fare for the round trip will be effective. Announcements concerning special trains will be made later. Convention headquarters will be at the Hotel Sherman. John Ericson, city engineer of Chicago, is chairman of the Chicago committee on arrangements. Further information can be obtained, as available, from Arthur E. Gorman, chief sanitary engineer, Municipal Pier, Chicago, Ill.

VIRGINIA PUBLIC HEALTH ASSOCIATION AND CONFERENCE OF STATE HEALTH WORKERS

The conference of State Health Workers of Virginia was held February 14 to 18, and the Virginia Public Health Association February 16, both at Richmond. The conference meetings provided for four general sessions for all workers, and section meetings for bacteriologists, public health nurses, and health and sanitary officers. The latter sections considered the subjects of malaria control, towns and village sanitation, methods of securing safe water supplies, sanitary toilets and toilet construction, and forms of rural health organization. Dr. R. W. Garnett, Daunville, presided at the meeting of the Virginia Public Health Association, at which were discussed vaccination, diphtheria control, and publicity methods.

AMERICAN WATERWORKS ASSOCIATION. FLORIDA SECTION

The second meeting of the Florida Section, American Waterworks Association, will be held at Hollywood Hotel, Hollywood, Fla., April 12 and 13. The general subject for discussion will be the the water works problems of Florida. E. L. Filby, Chief Engineer, State Board of Health, Jacksonville, is secretary.

HIGHWAY ENGINEERS' ASSOCIATION OF MISSOURI

The twentieth annual meeting of this association was held at the Missouri Hotel, St. Louis, Mo., February 16-18.

SOCIETY OF AUTOMOBILE ENGINEERS METROPOLITAN SECTION

Widespread use of the private automobile has developed new tastes in public transportation and a demand for speedy, de luxe service on rubber tires, R. N. Graham, manager of railways, Pennsylvania-Ohio Electric Company, told the Metropolitan Section of the Society of Automotive Engineers which met at the Woodstock Hotel, N. Y., Feb. 17. The de luxe bus, he declared, was the vehicle to supply this service.

Speaking on the subject of 'The Bus In Urban Transportation," Mr. Graham, whose company operates 57 buses in city service, said that the greatest field for the bus was to be found in special, supplementary service from suburbs to the center of the city at a comparatively high rate of fare, thus furnishing unusual conveniences to customers who do not object to the higher charge.

Mr. Graham defined the place of the 25 to 29-passenger bus in cit yservice as, first, on routes not exceeding 3 miles where traffic is dense; on longer cross-town routes where there is intermediate traffic; on routes reaching territory unserved by street cars and in high speed, de luxe service at a special fare.

ASSOCIATED GENERAL CONTRACTORS

The new officers of the Associated General Contractors of America, as reported by the tellers committee to the eighth annual meeting of the association, recently held at Asheville, N. C., are as follows:

President Sumner Sollitt; vice-president-at-large, L. C. Wason; vice-president, Zone 2, H. H. Wilson; vice-president, Zone 4, W. A. Snow; vice-president, Zone 6, H. P. Treadway; vice-president, Zone 8, G. W. Gauntlett; director, districts 2-3, J. W. Harris; director, districts 4-5, W. R. Hughes, Jr.; director, district 7, T. J. Baker; director, districts 12-13, J. W. Mann; director, districts 14-15, W. A. Bechtel; director, district 16, J. M. Clifton.